EVOLUTION AND PHILOSOPHY

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SANCTO THOMAE AQUINATI

PRINCIPI PHILOSOPHORUM

ET

MAGISTRO MEO

I take a very low view of "climates of opinion" In his own field every man knows that all discoveries are made and all errors corrected by those who ignore "climates of opinion"

C S Lewis

Government by average opinion is merely a circuitous method of going to the devil Those who profess to lead but in fact slavishly follow this average opinion, are simply the fastest runners and the loudest speakers in the herd which is rushing blindly to its destruction

T. H Huxley

PREFACE

Biologists as such are not expected to be interested in philosophy, but, as thinking people, they probably all are to some extent It is understandable, therefore, that many are attracted to philosophic views that appear to derive from, or align with, current theories in natural science Often, however, there appears an irrational and unscientific tendency to resent a critical approach from the angle of some other discipline—to say in effect "this belief is based on Science and admits of no argument" But any subject that can no longer be debated is in danger of the authoritarian groove, and to me it seems consistent with the testing disciplines of field and laboratory to allow that the implications of even the most attractive theory should be subjected to fair testing from every possible angle of approach

No exception need be taken to the approach which Dr Duggan makes from the angle of the philosophy of Scholasticism, because he is careful to deal as well with a summary of the biological evidence, evidence which he considers to be adequate to support theories of modified or restricted evolution This is as far as many competent biologists are prepared to go, although admittedly they are not in a majority among writers on popular science, with whom what the author calls Extreme Evolutionism is a strong vogue

Another objection, which I think not relevant, is that the views of this or that writer are coloured by a personal or professional bias None of us is free from bias of one kind or another, and it is unexceptionable as a stimulus if arguments are presented fairly and comprehensively as these appear to be One cannot predict how far specialists in all branches of biology will find Dr Duggan's review fair and adequate, but I have found his comments in fields in which I have done some study refreshingly stimulating, and should for this reason like to commend his book to students of biology

R A Falla
Dominion Museum, Wellington

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INTRODUCTION

EVOLUTION AND MODERN THOUGHT

THE principal contribution of the nineteenth century to human thought is the idea of Evolution There were evolutionary thinkers in earlier ages, but the concept of Evolution as an all-embracing synthesis, as the ultimate explanation of reality, has been a dominant element in human thought for barely one hundred years Many factors contributed to the triumph of the doctrine of Evolution eighteenth century Materialism, itself a development of the Mechanistic philosophy of Descartes, Hegelianism, for some time the official teaching of the German universities, and Positivism, which substituted natural science for philosophy —all these helped to prepare the minds of men to accept the evolutionary idea Perhaps the most important of these was Positivism, the theory that scientific knowledge alone is valid, if Positivism were true, natural science would take the place of philosophy and scientific generalizations would occupy in human thought the place formerly reserved to philosophical views Philosophy is not to be disposed of so easily, and what usually results from the acceptance of Positivism is that philosophical ideas are unwittingly intermingled with scientific theories and if the scientific theories are plausible, people accept not only these theories, but also, without being aware of it, the philosophical ideas that accompany them There is a good deal of philosophy, as well as the scientific theory of evolution by natural selection, in *The Origin of Species*, and the majority of Darwin's readers were so impressed by the vast array of facts which he brought forward in support of his scientific theory that they accepted his philosophical ideas as well Darwin was not a very coherent thinker, and the Mechanistic Materialism that is the underlying philosophy of *The Origin of Species* and *The Descent of Man* is not very clearly formulated in those books It was E. Haeckel who, in that thoroughgoing way the

Germans have, elaborated Darwin's philosophical ideas into a complete system, which he expounded with great propagandist skill for more than fifty years. Haeckel did more than anyone else to convert the men of the second half of the nineteenth century to the doctrines of Materialistic Evolutionism. By the end of the century, Evolution was accepted as axiomatic in almost every branch of human knowledge—in biology, psychology, sociology, ethics, history of religion, economics, politics. It was no longer a theory but an incontrovertible truth, like the Copernican account of the solar system or the law of gravity. "We have at least attained to a clear view of the fact that all the partial questions of creation are indivisibly connected," wrote Haeckel, "that they represent one single, comprehensive cosmic problem, and that the key to this problem is found in the one magic word—evolution"[1] Evolution was the "Gospel" of the modern world,[2] and to reject it was to prove oneself guilty of ignorance or prejudice

The idea of Evolution still dominates large sectors of modern thought In some quarters the old dogmatism has given way to scepticism, and Evolution is no longer regarded there as an unassailable truth, but as the only reasonable working hypothesis, the only alternative to unacceptable theories involving "metaphysics" or "mysticism" However, this scepticism is confined to the higher levels of contemporary thought; it has not yet permeated downwards, and the great majority of educated people accept Evolution as self-evidently true With Julian Huxley, they regard Evolution as "the modern synthesis," and for most of them a modern synthesis is necessarily better than an ancient or a mediaeval one In a word, the prevailing "climate of opinion" is still favourable to the doctrine of Evolution.

The average educated and half-educated person is quite content to allow his basic ideas, the fundamental assumptions of his philosophy of life, to be determined by the "climate of opinion" in which he is reared When he has been taught from primary school to university that Evolution is accepted without question by every intelligent and well-informed person—and that

[1]The Riddle of the Universe (Tr. J McCabe), Watts, London, 1899, p 238

[2]"The Gospel of Evolution" is the title of a book by Prof J A Thomson, Newnes, London, 1925

is what he is taught in New Zealand—he is almost certain to accept it as axiomatic and never submit it to critical scrutiny The philosopher, however, is more exacting in his intellectual demands than the average educated person. In the first place, he is not satisfied with the vague sense in which the term "Evolution" is frequently employed, e g, as in this introduction so far, but wants to know exactly what it signifies in any particular context Secondly, when he has formed a clear and distinct idea of the various theories of evolution, he examines with a critical eye the proofs brought forward in support of each, accepting or rejecting a theory according to the cogency or otherwise of the proofs it offers.

In the following pages, various evolutionary theories, some mainly philosophical, and others mainly scientific, are subjected to critical analysis, and the reader is invited to don for a while the philosopher's mantle, ignoring the almost overwhelming weight of modern authority in favour of Evolution, and judging the evolutionary theories on their own merits If he comes to the same conclusions as the writer, he will find himself at variance with the majority of his contemporaries and exposed to the rigours of an unfavourable "climate of opinion"—not a terrifying prospect for one who really loves the truth. If, on the other hand, he does not find the arguments set out in these pages convincing, he will not have wasted his time, for he will have made the acquaintance of a comprehensive survey of the various theories and so will be better able to distinguish between the different elements of the problem of Evolution when he reads other works on the subject

This treatise is divided into three parts, corresponding to the three philosophical problems with which the various evolutionary theories are principally concerned

The first part deals with the fundamental problem of philosophy: What is the nature of reality? After a brief discussion of the views of Hume and Kant, who dismiss this metaphysical problem as meaningless, we consider in turn the principal solutions that have been offered by philosophers. We take first the various metaphysical theories that regard the universe as self-sufficient and deny that it depends for its existence on any other being Some of these theories are evolutionary and others are not, but all of them, as we shall

show, involve some absurdity. We then establish that the universe in which we live, and of which we form part, is intelligible only if we admit that it depends on an unchanging reality who is its cause and is quite distinct from it, the Reality that is commonly signified by the name "God"

In the second part of the treatise we are concerned with the problem of the first origin of life on earth. We show that the Scholastic theory of Moderate Vitalism is true and then proceed to demonstrate the absolute impossibility of spontaneous generation If we are to save the principles of reason, we must attribute the origin of life to a special exercise of Divine causality, and furthermore, this Divine intervention must have been threefold, to account for the origin of each of the forms of life found on earth—plant, animal, human The discussion of this problem pertains to the department of philosophy known as natural philosophy, but it is obvious that the solution a philosopher adopts will be largely determined by his system of metaphysics

We discuss in the third part of the treatise the origin of the various forms of life within the plant and animal kingdoms The question is, whether the Divine causative action, which brought each of these forms of life into existence, directly produced in each kingdom a single living form, from which all the others would have arisen by evolution, or a considerable number of distinct forms? Although this problem has to be solved in accordance with the evidence provided by the various departments of biology, it pertains nevertheless to natural philosophy

Since the first part of the treatise is concerned with metaphysics, the most abstract part of philosophy, many readers will probably find it more satisfactory to read this section last All that the reader needs to take from this metaphysical part in order to make the other parts intelligible is the rational certitude that the universe depends for its existence on an unchanging First Cause, distinct from itself, whom we call God; in fact, the rest of the treatise will be intelligible, even if his assent to this proposition is only provisional The order in which the treatise has been written is demanded by the logic of the case, and so, even though it might prove unsuitable for some readers, it was not possible to depart from it.

PART I

THE NATURE OF REALITY

THE NATURE OF REALITY

The evolutionary theories that we have to consider in this part of our treatise are metaphysical theories, intended to provide the mind with an insight into the nature of reality considered as a whole, each of them represents a philosophical conception of the universe and of man's place in it, a Weltanschauung

Most of those who have enjoyed the benefit of a university education are suspicious when they hear the word "metaphysics," and this is not surprising, for if the modern university can be said to subscribe to any creed, that creed is an anti-metaphysical Positivism This prejudice against metaphysics is a legacy from Kant and the English Empiricists such as J S Mill Kant dismissed metaphysics as a grandiose delusion and regarded the persistent tendency of philosophers to construct metaphysical systems and of plain men to think metaphysically as symptoms of an almost incurable weakness of the human mind, and it must be confessed that the metaphysical theories propounded by the German thinkers who followed him did much to convince the ordinary common-sense person that there was a good deal in what Kant had to say Metaphysics came to be regarded as mere *a priori* speculation completely divorced from the concrete facts of everyday experience and scientific observation, and the metaphysician was typified by the philosopher who shut himself in a dark room in order to exclude the thought of material things completely from his philosophical speculation However, while the aberrations of some metaphysicians may help to explain, they do not justify the acceptance of Positivism Positivism is a fair-weather creed, a product of the relatively stable world of the nineteenth century, when men could convince themselves that human progress was assured and that the principal problems confronting man were problems of science and technology, namely, of discovering the best means of speeding-up the inevitable progress of humanity The events of the last forty years have made it harder to cling to Positivism, they have compelled us to ask, with some anxiety, the basic questions about God and

man, which Positivism had relegated to the limbo of outworn speculation Metaphysics is slowly coming back into favour

Metaphysics, as Aristotle and St. Thomas understand it, is simply the fruit of a profound and orderly philosophical inquiry into the meaning of truths which everyone in his right mind admits but of which few grasp the full significance Because man is a rational, he is also a metaphysical animal he cannot think at all without committing himself to a number of statements that have a metaphysical significance, but it is only the philosopher who disengages this metaphysical content and knows it for what it is Thus the ordinary unphilosophical person knows quite well what he means when he says, "My pet dog is real, but a winged horse is not real", but it takes a philosopher, and more precisely, a metaphysician, to appreciate fully the implications of this statement It is the task of the metaphysician, then, to inquire what we mean when we say that a thing is real, or exists in reality He is concerned with the most general aspect of things, namely, that they are things, i e., beings which exist independently of our thought about them. He is not concerned with the differences that enable us to distinguish, for example, between a horse and a potato, since he considers them according to this feature that they have in common—that they are things He discusses the various senses in which we use the word "thing," and the properties which every thing must possess simply because it is a thing, viz. that it is one with itself, is capable of being known by the intellect, and can be desired as a good Finally, starting from this most general consideration of the things of which we have direct experience, he endeavours to find an ultimate explanation of the whole of reality, that is, an all-embracing view of the universe which, by its evident intelligibility, satisfies the mind that it is a true insight into the nature of reality and in its essentials the most adequate to which the human mind with its limited powers can attain

Although we are mainly concerned in this part of our treatise with evolutionary metaphysical theories, it is necessary, if we are to appreciate their significance properly, to consider them in the context of a number of other philosophical systems which offer a different solution of the same problem When we classify all the various systems of philosophy according to their attitude

towards this problem—the nature of reality—we find that they fall into two main groups: those which deny that the human mind is capable of arriving at any certain knowledge regarding the nature of reality, and those which affirm that the human mind is capable of attaining to such knowledge To the first group belong the theories of Hume and Kant and of all those who hold that a valid metaphysics is impossible The second group includes all those theories which admit, at least implicitly, that the human mind is capable of a true insight into the nature of reality and so can formulate a valid metaphysics.

When we examine this second group—the theories that affirm the possibility of a vālid metaphysics—we find that these again fall into two classes the atheistic theories, which deny the existence of any reality transcending the universe, and the theistic theories, which hold that the universe is not the ultimate reality but depends on a transcendent Being, distinct from the universe Of the atheistic theories, some, like the theory of Parmenides, deny that change is real and hold that the universe is the unchanging, absolute Being, while others, like the evolutionary philosophies, maintain that change is real and that the universe, which is subject to unceasing change, is the ultimate reality. Aldous Huxley sums up rather neatly the fundamental difference between the theistic metaphysics of the Perennial Philosophy and the atheistic metaphysics of evolutionary philosophy "From Hobbes onwards," he writes, "the enemies of the Perennial Philosophy have denied the existence of an eternal now According to these thinkers, time and change are fundamental, there is no other reality Moreover, future events are completely indeterminate, and even God can have no knowledge of them Consequently God cannot be described as Alpha and Omega—merely as Alpha and Lambda, or whatever other intermediate letter of the temporal alphabet is now in the process of being spelled out "[1]

We shall now deal with the various philosophical theories regarding the problem of the nature of reality, discussing very briefly the anti-metaphysical theories of Hume and Kant, and devoting most of our attention to a number of evolutionary systems of metaphysics and the theistic metaphysics that contradicts them

[1]The Perennial Philosophy, Chatto and Windus, London, 1946, p 213

1

SYSTEMS THAT REGARD METAPHYSICS AS A DELUSION

AMONG modern thinkers, David Hume is the one who most nearly approaches the extreme of total scepticism According to Hume, we cannot affirm with certainty that anything exists beyond the present state of consciousness, and so we cannot make any certain statement about the existence, and still less about the nature, of things as they are outside the human mind. Such intellectual nihilism is utterly destructive of all the hard-won fruits of human thought, scientific as well as philosophical, and few have been found who are prepared to go all the way with Hume Hume himself was keenly aware that his theory contradicts a primary datum of consciousness, viz , our perception of conscious life as a unified whole [1]

Immanuel Kant attempted to steer a middle course between the scepticism of Hume and the dogmatism of the metaphysicians He agreed with Hume that metaphysics is a delusion, but tried to safeguard the validity of mathematics and the physical sciences He held that we can affirm with certainty that "noumena," or things in themselves, exist, but denied that we can know anything of their nature The "noumenon" must exist, he argued, because our sense-impressions must have a real cause, but what the "noumenon" in itself is like is something we can never know Critics were not slow to point out that Kant was not entitled to affirm even the existence of the "noumenon," because for him the principle of causality was only an *"a priori* form" of *thought* and could not legitimately be used to establish the existence of a *real* cause of sense-impressions In other words, after laying down that the principle of causality ("Every effect must have an adequate cause") expresses only a necessary

[1] Cf A Treatise of Human Nature, Appendix (ed L A Selby-Bigge), Clarendon Press, Oxford, 1896, pp 633-636

connection between our thoughts and need not apply to reality as it exists outside the mind, he had proceeded to argue that the change within the mind implied in sense-knowledge must have a real cause outside the mind, the inference, on his own principles, was invalid Furthermore, in asserting that some reality exists outside the mind, he had contradicted his other statement that this reality is unknowable, for if it can be affirmed that something exists, then it is not truly unknowable

For a detailed criticism of the views of Hume and Kant and their numerous followers, we must refer the reader to the various Scholastic treatises on epistemology [2] The fundamental error of these philosophers is their subjectivist assumption that knowledge is primarily the awareness of one's own conscious states This assumption, a legacy to modern philosophy from Descartes, creates an impassable gulf between the mind and objective reality, and leads inevitably to complete scepticism Those who make the assumption regard it as self-evident, but far from being self-evident, it contradicts the immediate testimony of consciousness regarding the nature of knowledge For consciousness testifies that knowledge is primarily and essentially an action whereby the knower is aware of something other than himself as other than himself Our consciousness of self as a subject knowing the object is secondary In the case of the human intellect, the object that is primarily and directly known is the being of material things, the intellect in its primary intuition contemplates these things as possessing real existence and as governed by the various objective necessities which the possession of existence entails In its act of knowledge the intellect affirms the existence of reality, and simultaneously it knows that reality cannot be self-contradictory or lack a sufficient reason In its primary act it affirms what *is*, and that is why the verb "to be" is used to signify both logical predication and objective identity, a state of affairs which Bertrand Russell regards as a disgrace to the human race,[3] but which simply

[2] Cf J Maritain, Les Degrés du Savoir, Desclée, Paris, 1932, pp 138-263, 399-484 Also P Coffey, Epistemology, Longmans, London, 1917, J Rickaby, The First Principles of Knowledge, Longmans, London 1901 C E M Joad expounds a similar view of knowledge, Decadence, Faber and Faber, London, 1948, ch VI-VIII

[3] Quoted in L S Stebbing, A Modern Introduction to Logic, Methuen, London, 3rd Edn, 1942, p 103

bears witness to the unshakable confidence of the human intellect in its own power to know what is. In fact, the intellect can only be defined as the power of knowing that which is as that which is, for no other conception of the intellect makes sense Accordingly if man's possession of an intellect has any significance—and we might just as well be cows or cabbages if it has not—man can know being as being, and metaphysics, which is the philosophy of being considered as being, is possible

2

SYSTEMS THAT ADMIT THE POSSIBILITY OF A VALID METAPHYSICS

UNDER this head we have to consider those systems which do not despair of the capacity of the human mind to arrive at a valid knowledge of extra-mental reality and which expound a positive theory of metaphysics. As we have said, all such systems fall into one or other of two groups, according as they deny or affirm the existence of God It is obvious that philosophies will differ fundamentally if they differ on this issue, the atheist or the pantheist has a radically different conception of the universe from the theist, because for the atheist or pantheist the universe is the sum-total of all that is, whereas for the theist the universe is a number of finite realities which completely depend for their existence on God, who is Infinite Reality and would lose nothing of His perfection if the universe did not exist Hence we divide metaphysical theories into two main groups—those that deny God, and those that affirm God

METAPHYSICAL SYSTEMS THAT DENY GOD

When the human intellect attempts to explain the nature of reality without including God in the explanation, it oscillates between the two poles exemplified in ancient times by the theories of Heraclitus and Parmenides According to Parmenides, reality is absolutely stable and change is a mere illusion, whereas for Heraclitus it is the stability that is illusory and only the change is real Every philosopher who attempts to construct a metaphysical system from which God is excluded, will, if he is completely logical, be led to one other of these extremes, and whichever way he goes he ends up in absurdity The Heraclitean extreme, which is the one in fashion at the present day, is, if anything, the more absurd of the two But first let us consider the views of Parmenides

According to Parmenides, reality is not subject to change. There is, he said, a single, unchangeable reality, which is Being. Being is, non-being is not, and there is not and cannot be any change or becoming He proved the impossibility of change in this way Being cannot change, for if it changed it could only change into being but it is already being, and a thing cannot change into what it already is; on the other hand, non-being cannot change into being, for from non-being nothing can ever come—nothingness can never produce reality There is no middle term between being and non-being and change is therefore absolutely impossible It is true that the senses seem to testify to the reality of change, but we must abandon the testimony of the senses as illusory in face of the clear, unquestionable verdict of the intellect By a similar process of reasoning, Parmenides established to his own satisfaction that reality is one and not manifold Let us suppose, he said, that being is manifold, i e, that there are several beings There can be several beings only if one possesses some being which the other does not—the reason of difference between them must itself be being, for if it were non-being, these things would not be distinct from one another but identical But since each of them is being, and the reason of difference between them is being, it does not really distinguish them from one another since it is identical with both of them Therefore being cannot be manifold, but must be one and indivisible

Parmenides was so carried away, one might almost say intoxicated, with his intuition of being, that he rejected our intuition, equally certain and direct, that being is changeable and manifold His objection that this second intuition is worthless because it is based on sense-experience cannot stand, for our intuition of being itself is based on sense-experience The fact is that our first intuition of being is of being as manifold, and Parmenides' mistake was to ignore the manifoldness implicit in the notion of "being" itself, the idea is not, as he thought, univocal, but analogous It was this that led him to affirm of the being that is the object of direct experience what is true only of the Infinite Being of God

The theory of Spinoza in its essentials is very similar to that of Parmenides Spinoza lays down as his basic principle that Substance is the unique reality, and then attempts in vain

to account for the apparent multiplicity of the beings of which we have direct experience

At the opposite pole from Parmenides we have the theory of Heraclitus, as commonly expounded, a pole which the various systems of evolutionary metaphysics that are our main concern approach in varying degrees of proximity. Some are almost identical with it, while others fall short of its standard of evolutionary purity The most satisfactory, and, with the space at our disposal, the only practical procedure, is to divide these evolutionary systems into the main groups into which they naturally fall and to discuss in some detail one representative of each group When the reader has seen a detailed criticism of several different systems, he should have grasped the philosophical principles that will enable him to perceive the fundamental weaknesses of any other evolutionary system he may have occasion to study

All the various evolutionary systems belong to one or other of three main groups To the first belong those which assert that reality is nothing but a process of change, e g , Heraclitus, Bergson The second includes those which regard reality as a permanent substratum undergoing perpetual change Some of these hold that in this reality there is no sharp distinction between mind and matter, e g , Haeckel, whereas others affirm that there is a sharp distinction between the two, e g , Lloyd Morgan In the third group, which is perhaps reducible to the second, we place the not very intelligible Hegelian theory that reality is an evolving Idea We shall discuss in turn the views of Bergson, Haeckel, and Hegel

THE METAPHYSICS OF BERGSON REALITY IS A PROCESS OF CHANGE In his book *Creative Evolution,* published in 1907, Bergson put forward an evolutionary system of metaphysics which has exercised a considerable influence on modern thought Although his later works contain a modification of some of the views expressed in *Creative Evolution,* he does not seem in these later works to have abandoned any of his fundamental theses We shall confine our attention here to the views expounded in this, his principal work

Although Bergson rejects decisively Darwin's theory of evolution by natural selection, he accepts as an established truth of biology an extreme form of Transformism, and with this

biological theory as his starting-point, he proceeds to elaborate his system of metaphysics The whole universe is a single evolutionary flux, a self-creative process of becoming, whose future manifestations are undetermined and therefore neither actually known nor capable of being known by any intellect whatsoever. There is one all-embracing and supreme reality, and this reality is a process of becoming, a vital flux, the onward surge of life to levels that are ever higher but otherwise unpredictable "Life," he writes, "evolves before our eyes as a continuous creation of unforeseeable form"[1] And again, "Life is an evolution We concentrate a period of this evolution in a single stable view which we call a form, and when the change has become considerable enough to overcome the fortunate inertia of our perception, we say that the body has changed its form But in reality the body is changing form at every moment, or rather, there is no form, since form is immobile and the reality is movement What is real is the continuous change of form, the form is only a snapshot view of a transition Therefore, here again our perception manages to solidify into discontinuous images the fluid continuity of the real."[2] In such phases as "there is no form," "the reality of movement," "the fluid continuity of the real," we catch an authentic echo of the dictum of Heraclitus. *"Panta rhei"*—all is change, nothing is ever the same from one instant to the next To the universal Becoming, which is the only true reality, Bergson gives various names He calls it "becoming," "life," "the *élan vital*" (vital impulse), "consciousness," "supra-consciousness," "duration," "will" He frequently declares that the life of all living things is a single whole "We must no longer speak of *life in general* as an abstraction," he writes, "or as a mere heading under which all living beings are inscribed At a certain moment, in certain points of space, a visible current has taken rise, this current of life, traversing the bodies it has organised one after another, passing from generation to generation, has become divided amongst species and distributed among individuals without losing anything of its force, rather intensifying in proportion to its

[1]Creative Evolution (Tr A Mitchell), Macmillan, London, 1911, p. 31
[2]Ibid, p 318-319

advance. The essential thing is the continuous progress indefinitely pursued, an invisible progress, on which each visible organism rides during the short interval of time given it to live."[3]

To remove the objections that arise spontaneously in the intellect when it considers this metaphysical theory, Bergson has formulated a theory of knowledge which denies that the intellect is competent to pass judgment on his metaphysics.

The intellect, he declares, cannot apprehend the unique, all-embracing reality that is Creative Evolution, because the intellect can understand only what is static, and if it endeavours to apprehend what is dynamic and moving, it can do so only by representing it as static, that is, by representing it falsely. He compares the intellect to the cinematograph, which falsifies movement by representing it as a succession of momentary states. Since change completely eludes the grasp of the intellect, and all reality is a process of change, the intellect is quite incapable of attaining to a knowledge of reality as it is in itself. In intellectual knowledge, we have to think of things as "beings" or "things," and regard change as necessarily belonging to some subject, some thing, which undergoes the change, but this is simply because our intellect does not—is not meant to—provide us with speculative or metaphysical knowledge. Intellect is a power which has been evolved in the human organism as a means of providing it with practical knowledge, with an effective technique for meeting the requirements of its physical environment. The true function of the intellect is to enable us to employ material things so as to meet our bodily needs. If we are to handle matter effectively we must create divisions in the fluid continuity of the real, and so the intellect parcels matter out into manageable lumps. To do this it employs such notions as "being," which have a purely pragmatic value and do not correspond to reality as it is in itself.

If we desire to obtain a true speculative knowledge of reality and to develop a sound metaphysics, we must transcend intellect and rely on what Bergson calls "intuition." "We must," he writes, "break with scientific habits which are adapted to the fundamental requirements of thought, we must do violence to the mind, go counter to the natural bent of the intellect. But

[3]Creative Evolution, pp. 27-28. Cf. pp. 46, 135, 243, 263, 273, 280.

this is just the function of philosophy."[4] He describes the "intuition," which the philosopher is to employ in preference to intellect, as analogous to the instinct of animals. "By intuition," he writes, "I mean instinct that has become disinterested, self-conscious, capable of reflecting on the object and enlarging it indefinitely."[5] Through "intuition" we feel ourselves to be one with reality, we "install ourselves within duration," we "enter within the flux of becoming," we become directly conscious of the vital impulse, of the Duration in which we participate. Thus the object of intuition would seem to be life as it goes on within ourselves, our own vital processes; through our awareness of these processes, the vital impulse, which is the unique reality, would be conscious of itself, since life in us is identical with the one, indivisible impulsion that is Life itself.

The knowledge we acquire by intuition is obscure, whereas intellectual knowledge is clear. "Intelligence is the luminous nucleus around which instinct, even enlarged and purified into intuition, forms only a vague nebulosity."[6] Nevertheless, it is intuition that really puts us in contact with reality.

Bergson claims to be a Dualist, and he does make some kind of distinction between life or spirit on the one hand, and matter on the other. Matter, he says, is an inverse movement, a flow in the opposite direction to that of the vital impulse. If we compare the upward movement of life to the fiery path of a rocket, matter corresponds to the extinguished remains that fall to the ground.[7] When the mind is at the highest pitch of its activity, it has the intuition of life, and as it relaxes, it falls to the level of intellectual thinking; in a similar way, matter is formed by moments of relaxation in the upward surge of life. Furthermore, as the process of relaxation in reality corresponds to the process of relaxation in the mind, so the results of the two processes are related to one another, the proper function of the intellect being to know matter. Or more correctly, the two processes are two aspects of the one process, viz., the inverse or retrograde movement of life. "Intellect and matter," he writes, "have progressively adapted themselves to each other in

[4]Creative Evolution, p. 31.
[5]Ibid., p. 186.
[6]Ibid., p. 187.
[7]Ibid., p. 275. Cf. p. 103, 261.

order to attain at last a common form This adaptation has, moreover, been brought about quite naturally, because it is the same inversion of the same movement which creates at once the intellectuality of mind and the materiality of things "[8]

A CRITICISM OF BERGSON'S METAPHYSICS.

Perhaps the most serious error in Bergson's philosophy is his denial that the intellect is a suitable instrument for philosophical inquiry This anti-intellectualism is demanded by his metaphysics, because he admits that our intellect can conceive of change only as taking place in some being which is the subject of that change, and admits also that for our intellect the existence of changeable being necessarily implies the existence of an unchangeable being on which the changeable being depends The illusion that there are things, he writes, "is natural to our intellect, whose function is essentially practical, made to present to us things and states rather than changes and acts But things and states are only views, taken by our mind, of becoming There are no things, there are only actions "[9] He declares that the metaphysics of Aristotle, according to which change is intelligible only if it is backed by an eternity of immutability, "marks out the main lines of a metaphysic which is, we believe, the natural metaphysic of the human intellect "[10] According to Bergson himself, then, we have to choose between the Bergsonian metaphysics of "intuition" and the intellect with the metaphysics that is natural to it, and he invites us, of course, to discard the intellect and its natural metaphysics If we are to arrive at a true metaphysical insight into reality, we must disregard intellect and dismiss being, the object of intellect, as unreal, we are to rely instead on intuition, accepting its verdict that becoming or change is the only reality

Intuition, as Bergson describes it, seems to be a complex mental state, partly sensory and partly intellectual By intuition, he says, we are conscious of life within us This consciousness of life, when we analyse it, turns out to be a combination of sense consciousness and intellectual consciousness We are aware, by means of the internal sense known as "sensus intimus," or sense-consciousness, of such data of the external senses as

[8]Creative Evolution, p 217
[9]Ibid, p 261
[10]Ibid, p 344

muscular tension, the beating of our heart, sounds from the world about us, by intellectual consciousness we are aware of our intellectual knowledge, whether this knowledge be concerned with the data of sense-consciousness or with other things. In the act of intellectual consciousness, the intellect formulates such judgments as "I am looking at a cow," "My heart is beating," "I am thinking about the nature of moral goodness," "I find that I cannot doubt my own existence"

Intuition, therefore, in so far as it differs from intellectual consciousness, is merely sense-consciousness, such as is found in the brute animals, and if we abandon intellect and rely on intuition, we do not, as Bergson says, transcend intellect, but descend to a lower level, the level of sense-knowledge.

In short, the metaphysician cannot transcend intellect, and if he attempts to do so, in favour of Bergsonian intuition, he merely subordinates the intellect to sense-consciousness, making it nothing more than a registrar of our ever-changing sense-impressions

This is not to say that the metaphysician has no need of intuition But the intuition on which he must rely is intellectual intuition, the intuition of being and of the properties that necessarily belong to being The intellect can understand becoming, but it can do so only in terms of being we can think of becoming only as the process by which some thing or being becomes Bergson holds that this is due to the imperfection of the intellect the intellect cannot think of becoming as "pure becoming," because it can only move on the lower plane of "being," and has to drag "becoming" down to this level in order to comprehend it The truth is, however, that the intellect finds it difficult to comprehend "becoming," because "becoming" is less perfect than "being," the connatural object of the intellect Bergson is in error when he places "becoming" on a higher level than "being," for it is obvious that "being" is more perfect than "becoming", for example, it is more perfect to be a master of Greek than to becoming a master of Greek, to be physically strong than to be becoming physically strong

Furthermore, Bergson's conception of reality as a process of pure becoming implies an absurdity It is true that all the beings of which we have direct experience are subject to change, but the statement that all *is* change is unintelligible. Bergson

admits that pure becoming is unintelligible—that is why he invites us to feel it Philosophy, however, is a matter of thought, not of feeling, and as philosophers, we have to think about becoming, just as we think about anything else of which we have experience, and we can think of becoming only as the process by which some *thing* becomes different from what it was This is the unalterable conviction of the intellect, a judgment following immediately on its intuition of being—that besides change there must exist beings which undergo change and that these beings are more real than the changes which they undergo A man, for example, possesses reality in a fuller measure than a movement of anger that momentarily alters the expression on his countenance, for the man can exist without the movement of anger, but the movement of anger cannot exist without him Bergson not only admits that this conviction that there are things which change is an intuition of the intellect, but he also admits that it is consistently verified in practical life Surely such a conviction, which embodies an immediate intuition of the intellect and is constantly verified in practice, should not be laid aside until its falsity is rigorously proved Bergson offers no such proof, but simply invokes an "intuition" which he describes as superior to intellect, but which is really, as we have seen, of a lower order of knowledge

Again, since Creative Evolution, or the process of becoming, is the whole of reality, it would have to be uncaused and self-sufficient But a self-sufficient process of becoming is a contradiction in terms, for a process of becoming or change must be initiated by the action of some efficient cause "The impetus (i e, the *élan vital*)," Bergson writes, "is finite, and it has been given once for all"[11] If a vital impetus is given, it must be given by some cause Moreover, the process of becoming would pass of itself from a state of lesser to one of greater perfection. as Bergson expresses it, "the current of life intensifies in proportion to its advance" But we say that such an increase in perfection is impossible, for it would be without a sufficient reason An increase of intensity in a process of change must be due to the action of some cause extrinsic to the change

Despite Bergson's claim to be a Dualist, his theory is Monistic, for he holds that life and matter are merely opposite

[11]Creative Evolution, p 267

currents in the one stream of change. Like all Monists, he fails to give a coherent account of the origin of matter. The original impulse, or *élan vital,* first starts off, and matter originates, he says, when the impulse turns back upon itself But how, we ask, does it come to turn back upon itself? Whence does it derive a direction antagonistic to itself? How can the very contradiction of a force spring from that force itself? How can descent be produced by ascent? In places, Bergson seems to suggest that this opposite movement results from the opposition offered by matter to the advance of life[12] But this is clearly a vicious circle, for the matter cannot offer resistance to the advance of life and itself be the product of this resistance

The Monistic character of Bergson's system appears also in his conception of life and becoming as one Life, he says, is "a current sent through matter," "an immense wave which, starting from a centre, spreads outwards," and individual souls are "nothing else than the little rills into which the river of life divides itself, flowing through the body of humanity" As Bergson admits, the intellect affirms that life and becoming are really manifold, that the life of each living thing is its own life, distinct from the life of every other living thing, and that each process of becoming is really distinct from every other The mind expresses to itself in the one concept, "life," what is common to all the different forms of life, and in the concept "becoming" what is common to all the processes of becoming Bergson's mistake is to transfer the unity which these concepts possess within the mind to reality as it exists outside the mind

The theory of Holistic Evolution put forward by Field-Marshal Smuts is in its essential features similar to the theory of Bergson According to Smuts, reality is a stream of activity, which gives rise by creative evolution to "wholes" of ever-increasing perfection, human personality being the most perfect "whole" thus far evolved He maintains that, as philosophers, we cannot establish the existence of God and consequently must regard the evolutionary process as self-sufficient, as requiring no other being to account for it. As we have just seen, the idea of a self-sufficient evolutionary process implies an absurdity

[12]Creative Evolution, pp 103, 280

THE METAPHYSICS OF HAECKEL REALITY IS EVOLVING MATTER
Ernst Haeckel, a professor of biology in the University of Jena, adopted the theory of Darwin soon after its publication in 1859 and incorporated it into a complete system of materialistic philosophy which he expounded with tireless energy to within a few years of his death in 1919 For the philosopher, his most important work is *The Riddle of the Universe,* which was published in 1899 His manner is crude and violently propagandist, and according to Professor Joad, "he is not generally regarded as a philosopher of the first rank,"[13] but he has the merit of being franker than most materialists in facing the implications of Materialism

According to Haeckel, the Universe or Cosmos is one substance, eternal and illimitable This single all-pervading substance, with its two attributes of matter and energy, fills infinite space, is in eternal motion, and is governed by one supreme law, the "Law of Substance" This "supreme law" is in fact a combination of two physical laws, the law of the indestructibility of matter and the law of the conservation of energy

The substantial unity of the universe is explained by the unity and omnipresence of ether "In my opinion," Haeckel writes, "the existence of ether is as certain as that of ponderable matter—as certain as my own existence as I reflect and write upon it"[14] He argues that ponderable matter is probably formed by the condensation of ether and that consequently we can arrange the states of matter in a continuous series—etheric, gaseous, liquid, fluid, viscous, solid

All matter is endowed with a rudimentary form of sensation and will, but these properties are manifested only when the matter attains a high degree of chemical complexity, or as we say, is alive Life arose in the first place by spontaneous generation complex chemical compounds were formed by the chance interplay of physical and chemical forces, and eventually this complexity reached a stage where the matter had the structure of a living cell The first organism thus formed, the *Monera,* was a very primitive and simple cell, but it had the power of producing offspring by dividing into two cells

[13]Guide to Philosophy Gollancz, London, 1936, p 495
[14]The Riddle of the Universe, p 231

Among the offspring of the *Monera* and their descendants there are chance variations, and in the struggle for existence that arises when the world becomes more populous, those individuals survive whose variations give them an advantage, and they hand on these variations to their offspring Thus from the primitive *Monera* a vast number of different species are formed by a process of natural selection Some types become extinct but others are formed to replace them, and thus the living world is gradually diversified until at last it possesses the immense variety of types that we now find

Man, the highest of living forms, is evolved from one of the higher apes, and he is not essentially superior to the other animals His psychical activity, like the psychical activity of the lower animals, and indeed every form of vital activity, is simply the product of complex physical and chemical forces. Free-will is consequently an illusion, and the human soul, so far as there can be said to be one, ceases to exist at death

As growth is followed by decay, so evolution is followed by devolution—the present ascending process will be followed by a descending one, and when this process of descent has reached its lowest point, the ascending process will begin again, and so on without end. Thus reality would resemble a wheel that is ever turning on its axle and going nowhere

A Criticism of Haeckel's Metaphysics

If Haeckel's contention that the material universe is the supreme self-sufficient reality were true, his other contention, that the universe is one substance, infinite and eternal, would also be true, for the supreme, self-sufficient reality must be one, infinite, and eternal A self-sufficient reality must be absolute, or uncaused, and what is uncaused cannot be manifold, finite, or of limited duration, it cannot be manifold, because each of the distinct entities would lack some perfection possessed by the other and could not of itself be a sufficient reason for the perfection which it possesses and the absence of the perfection which it lacks, it cannot be finite, for the same reason, and it cannot be limited in duration, for if it began to exist it would have to be brought into existence by a cause distinct from itself, and if it ceased to exist it would be subject to the cause which reduced it to non-existence

We shall now show that the material universe is not one substance, infinite and eternal, and consequently that it is not the supreme, self-sufficient reality

The material universe is not one substance We men form part of the material universe, and each of us is profoundly and intimately aware that he is no mere attribute of another being, but a being in his own right, a substance existing in himself, distinct from other men and from things that are not human Haeckel's Monistic theory contradicts this elementary certitude of the human intellect, and since it asserts that everything is identical with everything else, it makes coherent thought impossible The Monistic creed was summed up by the wit who wrote

> I am the batsman and the bat,
> I am the bowler and the ball,
> I am the pavilion cat,
> The roller, wicket, stumps and all

Such a creed is incompatible with the principle of contradiction, which is the primary law of human thought, for it affirms the real identity of what we cannot but regard as really distinct

All affirmation, Haeckel declares, should be based on experience and inference, if his thought were regulated by this principle, he could not affirm Monism, which is directly opposed to the clear testimony of experience The reason why the Monistic philosopher disregards the testimony of experience that reality is manifold is his assumption that Theism cannot be true There is a certain unity in the universe, and the ultimate explanation of this unity is that all the many beings of which the universe is composed derive their existence from the one First Cause, who is also the cause of the order that exists among them But if we begin by assuming that God does not exist, we shall probably explain the unity of the universe in a Monistic fashion, holding that the universe is one substance and that the realities which men commonly regard as distinct substances are no more than superficial modifications of this one substance

To prove the substantial unity of the universe, Haeckel appeals to the substantial unity of the ether which binds all its parts to one another This procedure is philosophically unsound In the first place, Haeckel takes a scientific hypothesis as if it

were a well-established fact, then he attributes to this scientific "fact" a metaphysical significance, and calls on us to accept this metaphysical view and abandon our primary certitude that material substances are manifold Furthermore, the scientific hypothesis which Haeckel regarded as an evident fact is now called in question by many scientists

The material universe is not eternal, and it is impossible that it should extend to infinity A S Eve, a modern physicist, writes "We see no evidence of an infinite, but rather a large finite amount of matter in the Universe. There is clearly stamped on the universe a great, but not an infinite antiquity By all the known laws of physics, the universe is a going concern, perhaps in middle age, which has not gone on forever, and will not continue for ever"[15] One of these laws of physics is the second law of thermodynamics, formulated by Clausius, which implies that the amount of force in the universe is constantly decreasing, so that, to quote Eve again, "the physical universe is proceeding, not to ruin, but to a dull uniformity"[16] Haeckel confuses "force" and "energy" and understands the principle of the conservation of energy as if it applied to force The truth is, however, that not all energy is force, but only such energy as is available to do work, and consequently the law of the conservation of energy does not imply that the amount of force in the universe is constant Haeckel's theory of repeated evolution and devolution demands that the force in the universe remain constant, and so it is not surprising that he rejects the second law of thermodynamics (regarded as axiomatic by modern physicists) as "erroneous" and "quite untenable"[17]

It is philosophically impossible that the universe should extend to infinity, for extension is a property of matter and it is impossible that an infinite property should belong to material substances, whose perfection is finite Nor is it possible that an infinite number of material things should exist simultaneously, for it is not repugnant to reason that another material thing be added to those already in existence, and a number that can be increased by addition is not infinite.

[15]The Great Design (ed Mason), Duckworth, London, 1934, pp 66, 74
[16]Ibid., p 76
[17]The Riddle of the Universe, pp 252, 253

The material universe cannot be the supreme, self-sufficient reality. A self-sufficient reality is one that requires no other to account for its existence or for any other perfection it may happen to possess. The material universe cannot be self-sufficient, for it is subject to change, that is, it passes from a state in which it lacks some perfection to a state in which it possesses this perfection and so contains some new reality that did not previously exist. After the change there is more reality in existence than there was before, otherwise there would have been no real change. Now the material universe cannot fully account for this new reality, because it cannot confer upon itself some perfection, some mode of being, that it did not already possess. If the perfection of the universe is increased, it must be increased by some being distinct from the universe, and this means that the universe is not self-sufficient. A being that is self-sufficient must be absolutely unchangeable, for whatever is changed must be changed by some being other than itself and so cannot account by itself for all the reality that it possesses, i.e., is not self-sufficient.

Haeckel ascribes all the phenomena in the cosmos to chance. "Neither in the evolution of the heavenly bodies nor in that of the crust of the earth," he writes, "do we find a controlling purpose, all is the result of chance." He then defines chance as "the simultaneous occurrence of two phenomena which are not causally related to each other."[18] On this theory, every effect resulting from the simultaneous occurrence of two or more phenomena would be attributed to chance, not to any nature pre-ordained to the production of such an effect and controlling the forces engaged in its production. To perceive the absurdity of such a theory it is enough to consider the uniformity of nature. The fact that a hen's egg always develops into a chicken and never into a pig shows that the various elements of which the egg is composed do not inter-act by chance and that the activity of all the parts is co-ordinated and directed to a predetermined end, the chicken. Chance effects are essentially indeterminate and variable, e.g., the winning numbers in a series of lotteries, the effects of natural causes, on the other hand, are determinate and invariable, and consequently they must not be attributed to chance. The way in which rocks, etc., are juxtaposed to form

[18] The Riddle of the Universe, p. 280

a particular island or mountain is due to the chance concurrence of various causes, and so no two islands or mountains are quite alike; but the human eye or ear has not been formed by chance, and that is why the structure of these organs is always the same Furthermore, even when effects are produced by the chance concurrence of several causes, each of the uncoordinated causes does not act by chance but in accordance with its own nature Whatever exists must have a determinate nature, for to exist at all, it must be some definite kind of thing; having a determinate nature, it will be ordained to the production of the effects of which such a nature is capable

The Haeckelian conception of change as cyclic, with evolution and devolution following each other endlessly, implies an absurdity, for at the end of all this change, the universe would be no different from what it was at the beginning, and so there would be no sufficient reason why there should be any change at all Nor is it of any use to say that there must be change because of the forces inherent in matter, such as chemical affinity and gravitation, for unless matter possessed these forces in order to achieve some pre-determined end, there would be no sufficient reason why it should possess these forces rather than quite different ones or no forces at all

Haeckel entitles one of his chapters "Our Monistic Ethics," but his materialistic metaphysics is really incompatible with any theory of ethics It is obvious that ethics presupposes human freedom, for it lays down what man ought to do, and unless a man is able to do what he ought to do, it is nonsense to say that he ought to do it On Haeckel's theory, a man can only do what he actually does, for human conduct is determined by physical and chemical forces over which man has no control[19] This is the nemesis of Materialism that it reduces human conduct to a level on which there can be no place for ethical considerations If, as Haeckel says, human nature "has no more value for the universe at large than the ant,"[20] there is no earthly reason why one group of men should not exterminate another group without compunction, in the same way as one nest of ants would wipe out another Forty years ago, Radl remarked that the influence of Haeckelian Darwinism in Germany had been and still was

[19]The Riddle of the Universe, p 93
[20]Ibid, p 249

very profound[21] This fact may furnish a clue to some of the events that have happened since that time

Systems of evolutionary materialism similar to that of Haeckel have been put forward by many modern thinkers, e g, S. Alexander, C Lloyd Morgan, B Russell, G Santayana, J B S. Haldane, Julian Huxley. Some of these hold that evolution is an emergence of unpredictable reality, and that the lower levels of development in the process of evolution cannot adequately account for the higher levels, such as life and consciousness, consequently they would not accept Haeckel's view that consciousness is nothing more than the inter-action of material particles On the fundamental issue, however, they all agree with Haeckel, for they all deny the existence of any reality distinct from the material universe

THE METAPHYSICS OF HEGEL REALITY IS AN EVOLVING IDEA The system of Hegel is a Monistic metaphysics, constructed to answer the question What is the relation between mind and matter, between the ego and the non-ego? Kant had stated the problem, making it the central problem of philosophy, and the German thinkers who followed him, dissatisfied with his solution, made it their main business to find a better one Kant held that the mind, or ego, knows only its own subjective modifications or phenomena, while the non-ego, or noumenon, is unknowable Fichte denied that there was any noumenon existing independently of the ego, and held that the sole reality is the ego, or thinking subject, which posits the non-ego within itself in order to know itself as ego Thus Fichte solved the problem by getting rid of the noumenon as a reality existing independently of human consciousness The mind can know matter, because matter is not outside the mind but is something which the mind forms within itself Schelling solved the problem by making ego and non-ego, human consciousness and matter, identical with the Absolute In the Absolute, considered as it is in itself, the difference between ego and non-ego disappears, for the Absolute is infinite, undifferentiated, and unchanging Being Hegel agreed with Schelling in holding that ego and non-ego are identical with the Absolute, but he rejected Schelling's conception of the Absolute as undifferentiated, on the ground that

[21] The History of Biological Theories (Tr E J Hatfield), Oxford U P, London, 1930, p 351

it would do away with the reality of finite being and make the Absolute like the night, in which all cows are black Moreover, if there were no differences in the Absolute, real change would be impossible and the Absolute would remain for ever in a static sterility Hegel held therefore that the identity of the Absolute with ego and non-ego does not imply that the distinction between ego and non-ego is eliminated; although finite things are one with the Absolute, they are not swallowed up in its infinity, similarly change, far from being repugnant to the nature of the Absolute, is the very law of its being

Hegel calls the one all-embracing reality the Absolute Idea, not in the sense that it is a thought expressed by an infinite mind, but to signify that it is absolutely rational The Absolute Idea is objective reason, and so whatever is real must be purely rational "Idealism," Stace remarks, "is perfectly consistent with the view that there was a time when no minds, human or divine, existed, when there was nothing but masses of incandescent vapour with no trace of life anywhere For such a world was still dependent on thought, was the product of thought, *was* thought—not subjective but objective thought"[22]

Since reality is perfectly rational, the metaphysical structure of reality can be known, at least in principle, by a process of deduction, for a body of knowledge that is purely rational is acquired by deduction Hegel attempted to give a complete account of reality derived by a process of deduction from his initial postulate regarding the Absolute Idea The fact is, however, that this account contains a good deal of matter that can be known only *a posteriori*, or, from experience, and his disciples generally admit that such a complete and exclusively deductive account of reality is at present beyond our reach

The great difficulty confronting all forms of Monism is to explain how the world, which is apparently finite being, can be identical with infinite being. This difficulty is insoluble so long as the Monist adheres to the elementary canons of thought, such as the principles of identity and contradiction Hegel removes the difficulty by declaring that his speculation is on a higher level than that of ordinary thought, Hegelian speculation is on the level of "reason," where the primary canon of thought is the "principle" of the identity of opposites He solves the problem

[22]The Philosophy of Hegel, Macmillan, London, 1924, p 28

of the relation between the finite and the infinite by affirming boldly that the infinite is the finite, the two, though really opposite, are nevertheless identical

Hegel divides philosophy into three parts (1) Logic, which treats of the Absolute Idea as it is in itself, (2) Philosophy of Nature, which treats of the Absolute Idea as gone out of itself and manifesting itself in the phenomena of nature—space, time, inorganic matter, plants, animals, (3) Philosophy of Spirit, which treats of the Absolute Idea as returned from otherness into itself, through self-consciousness in man, this return is complete and the Absolute Idea becomes fully conscious of itself as the totality of all that is, in the contemplation of the Hegelian philosopher

What Hegel calls "Logic" is really a system of metaphysics, for although it is an account of the mental processes as Hegel conceives of them, the mental processes are studied for the insight they give us into the metaphysical structure of the Absolute Idea, which is really identical with our thought

Taking our primary concept, the concept of "being," he argues that this is identical with its contradictory concept, "non-being," and since these contradictory concepts are identical, each may be said to pass into the other, this notion of a passage from "being" to "non-being" is expressed in the concept "becoming", in "becoming," therefore, the two contradictory concepts are synthesized into a higher unity Stace explains the Hegelian dialectic in these words " 'Pure being' has in it no determinations whatever, for we have abstracted from all determinations It is therefore absolutely indeterminate and featureless, completely vacant and empty, a pure vacuum It has no content, for content of any kind would be a specific determination This vacuum, this utter emptiness, is not anything, it is the absence of everything, of all determinations, quality, character But such absence of everything is simply nothing Emptiness, vacancy is the same as nothing And the pure concept of being is thus seen to contain the idea of nothing But to show that one category contains another is to deduce that other from it Hence we have deduced the category 'nothing' from the category 'being'

Since they are identical, the one passes into the other Being passes into nothing, and conversely nothing passes back into being In consequence of this disappearance of each

category into the other we have a third thought involved here, namely, the idea of the *passage* of being and nothing into each other This is the category of becoming."[23]

In positing itself, "becoming," which is the synthesis of "being" and "non-being," affirms its contradictory, and the contradiction between these two is resolved only in the higher unity of a further synthesis, "determinate being," or "quality", and so on, until a category is reached that does not give rise to any contradiction This last is the category of "Absolute Idea," the final category of the Logic

The Hegelian scheme of the categories of thought is thus presented as an organic whole, whose parts are all connected by deduction of the "thesis, antithesis, synthesis" type exemplified above This form of deduction, known as the dialectic method, is employed by Hegel throughout his philosophy He regards it as the expression, not only of the supreme law of thought, but also, because thought and reality are identical, of the supreme law of reality, so that when we have grasped the Hegelian system of categories, we have, *eo ipso*, an insight into the metaphysical structure of the Absolute Idea The Absolute Idea is both the subject and object of philosophical thought; as subject, it is the dialectic method, as object, it is the categories, that is, it knows itself as the categories by means of the dialectic method

In his philosophy of nature, Hegel attempts—as his followers admit, without much success—to formulate a purely deductive account of physical nature He considers the physical universe as the Absolute Idea gone out of itself and gradually returning into itself by a process of ascent, a process that reaches its completion only when the otherness of nature is overcome by spirit He is concerned only with the rational necessities of nature, not with particular phenomena, but notwithstanding the seemingly unlimited potentialities of deduction afforded by the Hegelian method of dialectic, his deductions of chemical and physical properties, of plant and animal life, are unconvincing, even to those who accept his principles Although he put forward his doctrine of gradual ascent as the expression of a metaphysical order and not as the account of a series of events that happened in time, this doctrine can, without any violence

[23]The Philosophy of Hegel, p 90

being done to his principles, be interpreted so as to harmonize with the theory of biological evolution

In the philosophy of spirit, Hegel deduces the various stages whereby the human mind by a dialectical ascent finally reaches the stage of absolute spirit These stages are subjective spirit—the world of consciousness, and objective spirit—the world of institutions that spirit creates for itself, e g, law, society, the state, absolute spirit, the final stage, is the synthesis of subjective and objective spirit Within each of these stages there are subordinate stages, and always the passage of spirit from one stage to the next is by the dialectic method "Absolute spirit," writes Stace, "is that final phase in which the spirit knows that in contemplating itself it is contemplating the Absolute But since such absolute spirit exists only as subjective human consciousness, it may further be said that absolute spirit is the knowledge, by human beings, of the Absolute All the modes under which human beings can be conscious of the Absolute, whether in art, religion, or philosophy, are phases of the Absolute"[24] The self-knowledge of the Absolute is found in its least perfect form in art, because thought is there expressed by means of a sense-object, religion is more perfect, for in religion thought is expressed in a form that is partly rational and partly sensuous or pictorial, in philosophy, absolute spirit reaches the summit of perfection, for in philosophy the form in which thought is expressed is purely rational Hegel discourses at length on the history of art, religion, and philosophy, in order to show how in each of these departments progress has been achieved by the synthesis of contradictories In philosophy, this dialectical process reaches its term with the formulation of Hegel's philosophy, in which the Absolute knows itself as Absolute Idea With the appearance of this philosophy, the Absolute Idea becomes conscious of itself as Absolute Idea—the world-process knows itself for what it really is "Philosophy," Stace declares, "is the knowledge of the Idea by itself For what is known is the Idea, and what knows, the philosophic mind, is itself now disentangled from sense, is pure thought, is Idea Philosophy is the existence of the Idea, and since in this, that the Idea should realise itself completely in existence, it attains its end, the philosophic spirit is accordingly to be regarded as the attainment

[24] The Philosophy of Hegel, p 440

of the end and purpose of the world-process The philosophic mind which should have attained omniscience would be nothing less than the mind of God . . This is the circle of philosophy. The Logic, with which we began, treated of the Idea Here at the end of the philosophy of spirit, we again reach the Idea, the Idea now as actual, existent in the philosophic mind It is here that the world-process is consummated."[25]

A Criticism of Hegel's Metaphysics

The system of Hegel, in the opinion of Cardinal Gonzalez, "represents the prodigious effort of one of the most powerful geniuses that history has seen It is staggering in its profound originality, in the fascinating unity of its applications, and in its vast proportions as a philosophical system. But," he adds, "this vast conception will always create a deep repulsion in the reflective mind that loves the truth, when on examining the theory closely, it sees that Hegel affirms the identity of being and nothingness, denies the validity of the principle of contradiction, regards the individual as no more than a drop in the torrent of the Idea, holds that victory and might are identical with justice, conceives the course of history as a fatalistic process of which the successive steps are all inevitable, asserts the identity of the human mind and the Divine, and makes of God a process of becoming"[26]

The fundamental error of Hegel's system is the Monistic assumption that all reality must be a single being, the Absolute Having made this assumption, he is logically compelled to affirm that the Absolute, which is infinite, is identical with the world, which is finite, that being is identical with non-being, and that the principle of contradiction must be set aside in favour of the Hegelian principle of the identity of opposites.

Monism is false, because, as we have pointed out, it contradicts the immediate testimony of experience that we are distinct individuals and not merely parts of a greater whole Moreover, it violates the principle of contradiction for it affirms that one and the same being, the Absolute, is both finite and infinite Thus Hegel writes "The answer to the question, how the infinite becomes finite, is consequently this, that there is no such thing

[25]The Philosophy of Hegel, p 516

[26]Histoire de la Philosophie (French Translation, Pascal), Paris, 1891, vol IV, p 67

as an infinite that is first of all infinite, and which is afterwards under a necessity to become finite . . . but it is *per se* already just as much finite as infinite. This question, founded as it is upon a rigid opposition between finite and infinite, may be answered by saying that the opposition is false, and that in point of fact the infinite eternally proceeds out of itself and does not proceed out of itself."[27] These statements are not really intelligible, for they are in conflict with the principle of contradiction, which governs all our thinking. As a Monist, Hegel is logical in regarding the identity of opposites as a first principle, for Monism implies that opposites are identical, but such a principle makes thought impossible. Aristotle pointed this out long ago, when he wrote that if we agree with those who hold that "being" and "non-being" are identical, "it follows that all would then be right and all would be in error, and our opponent himself confesses himself to be in error. And at the same time our discussion with him is evidently about nothing at all, for he says nothing. For he neither says 'yes' or 'no,' but 'yes' and 'no'."[28] This is clear enough, for if "being" and "non-being" are identical, we shall be able to substitute "is" for "is not" in any proposition without altering the meaning, and it will make no difference whether we say of a certain object that it is a horse or is not a horse. Under such conditions, thought becomes impossible.

The Hegelians sometimes object that this is a crude interpretation of their views, but it is difficult to see what other meaning Hegel's principle of the identity of opposites can have. Stace, after pointing out that the categories are definitions of the Absolute, continues: "It is of essential importance to understand that they are also, on the other hand, definitions of, or concepts applicable to, the actual existent universe, the external world of objects. They are just as applicable to this hat, that book, this tree, that star, as they are to the Absolute. They are the concepts by means of which we seek to make the universe intelligible."[29] If then the theory affirms that the Absolute is simultaneously being and non-being, we are entitled to conclude that it would apply the same categories simultaneously to any

[27] Quoted in Stace, op. cit., p. 148.
[28] Metaphysics, Bk. IV, ch. 4, n. 1008a (Works, ed. J. A. Smith and W. D. Ross, Clarendon Press, Oxford, 1908).
[29] op. cit., p. 126.

particular object, holding that it is at one and the same time a hat and not a hat.

Hegel's argument that the concept of "being" is so devoid of determination and significance as to be equivalent to the concept of "non-being" is refuted by the simple fact that when we say "is" we mean something quite different from "is not." In forming the concept "being," we do indeed abstract to a certain extent from the various particular kinds of being, but nevertheless the concept has a meaning. Thus when we say "John Smith is a being," we mean that John Smith is an object belonging to the real world and so differs from a flying horse, which is non-existent. Stace seems to have appreciated the force of this argument, for he writes "No matter what the object, merely to know that 'it is' is to know next to nothing about it."[30] If Hegel were right, this would have to be amended and "next to nothing" changed to "nothing", but perhaps that is going a bit too far, even for an Hegelian.

The deduction by which Hegel attempts to derive real becoming from the identity of being and non-being is invalid, for there is no reason why such identity should give rise to becoming. On the contrary, such an identity would make becoming impossible. "Indeed," wrote Aristotle, "from the assertion that things at the same time are and are not, there follows the assertion that all things are at rest rather than that they are in movement, for there is nothing into which they can change, since all attributes belong already to all subjects."[31] Real change is possible only if being and non-being are not identical, for real change requires that some being or mode of being which previously did not really exist begin to possess real existence. A thing cannot become what it already is. Accordingly, the Absolute Idea could not really *become* self-conscious by reaching the level of Absolute Spirit, as Hegel maintains. Because of the identity of being and non-being, the Absolute Idea would be self-conscious at the lower levels at which it is supposed to be not self-conscious, and being self-conscious at these lower levels, it could not really become self-conscious at the higher.

[30] The Philosophy of Hegel, p. 129.
[31] Metaphysics, Bk. IV, ch. 5, n. 1010a.

In the Hegelian theory, real contingency is impossible, because the whole of reality is nothing else than the necessary evolution of the Idea. Since the world-process is, at least in principle, deducible from the initial postulate of the identity of being and non-being in the Absolute, all that exists or happens must exist or happen by absolute necessity. This contradicts an immediate datum of experience, viz., that some of our actions are contingent, because when we act we are aware that it is within our power not to act. Moreover, we have sufficient insight into the nature of things to know that some of the things that do in fact exist could quite possibly not have existed.

It is a self-evident truth (the principle of causality) that when some new reality comes into existence, even if it is only a new perfection in some thing already in existence, this new reality must be brought into existence by an efficient cause adequate to it. For example, if a bar of iron that was cold becomes hot, this increase in temperature must be brought about by some cause distinct from the bar of iron. The Hegelian account of the evolution of the Absolute contradicts the principle of causality, for according to this theory the Absolute passes, of itself and independently of any cause, from a state in which it is devoid of consciousness to one in which it is self-conscious, and even if this passage is interpreted as a metaphysical deduction rather than a physical process, it will still be without a sufficient reason.

A Note on Dialectical Materialism

The Dialectical Materialism of Marx is a species of Hegelianism, the main point of difference being that for Marx the unique reality is to be conceived of as matter, not as Idea. The dialectical process that Hegel attributes to the Absolute Idea is altered by Marx into an evolutionary process that takes place in matter as the result of conflict between the opposite elements of which matter is composed. Matter, which has existed eternally, is a unity of opposites, a composite of contradictory elements, and since contradiction is necessarily productive of motion, matter is by its nature autodynamic.

The nature of motion is such that the motion proper to matter produces at least the quantitative development of reality, that is, in the world of nature, each reality moves towards its own negation in a manner that necessarily results in its develop-

ment or increase—as when the grain of barley is negated in germination and thereby reproduces itself a hundredfold

A continuous quantitative development of a reality often ends in a qualitative change, in the production of an entirely new form The emergence of every new form in the course of history is consequently to be explained as a leap in nature, as the sudden production of a qualitatively new reality terminating the quantitative development of an already existing thing

In the philosophy of Marx, therefore, the motion in matter would require no Prime Mover to account for it, the laws governing the evolutionary development of matter would be inherent in matter and would not depend on any Lawgiver external to the universe, and the coming into existence of new realities would be explained without reference to any First Efficient Cause In such a philosophy, as Engels said, "the last vestige of a Creator external to the world is obliterated"

A fundamental weakness of Marx's metaphysics is that his concept of matter, which he declares to be the only reality, is not at all clear, nor does he specify what he means by the "opposites" of which matter is said to be composed He regards matter as extended substance, existing independently of the human mind and undergoing real change, but whether he considers it to be one substance or many is not clear. If he holds that the material universe is a single substance, then we may urge against his view the difficulties, already mentioned, which beset all forms of Monism, if, on the other hand, he regards the material universe as a congeries of many substances, he cannot on his principles explain why these many substances cohere to form a universe The unity of the universe cannot be explained by the universe itself, for things that are of themselves distinct cannot account for their own union, there must then be some cause distinct from the universe which accounts for the fact that the many things of which the universe is composed form a universe, a unified whole; and the difficulty for Marx is that he does not admit the existence of any such cause distinct from the universe

Similarly, it is not enough for Marx to say that matter is constituted by the union of opposite factors or tendencies; to provide a philosophical explanation of matter, it is necessary to indicate a sufficient reason for the union of these opposite

tendencies, and in the Marxian theory such a sufficient reason is not forthcoming

The Marxians explain that when they speak of a thing "negating itself," they do not refer to any kind of self-negation, but to a self-negation that is in accordance with the nature of the object in question, thus, it is by negating itself in the manner proper to its nature that the grain of barley produces a hundred grains This amounts to an admission that there is an order in nature, that there are in matter natural patterns or structures which determine the course of development of such things as the grain of barley The existence of such an order in nature must have a sufficient reason to account for it It cannot, as the Marxians admit, be due to chance, and can be satisfactorily explained only if we admit that the material universe has been created by an Intelligent Cause

Finally, in asserting that the origin of completely new forms of reality is sufficiently explained by the tendency of evolutionary development to pass from quantitative change to qualitative, the Marxians fall foul of the principle of causality For, since the new reality contains by hypothesis more perfection than existed in its causes, this additional perfection would be without a sufficient reason to account for it But it is impossible that something should come into existence without a sufficient reason to account for it · you cannot pour water from an empty jug

Conclusion

We have examined only a few of the metaphysical theories that attempt to explain the nature of reality without admitting God, but these are representative of the main types, and when we have seen their weaknesses, we are in a position to appreciate the difficulties that confront any atheistic theory of metaphysics Every such theory begins with the supposition that God, in the sense of an unchangeable Being distinct from the universe, does not exist, to maintain this supposition, it is necessary either to accept the view of Parmenides that the universe is absolutely unchangeable being or to hold that the changeable universe is uncaused, self-sufficient being The first alternative cannot be reconciled with the evident fact that change is real, while the second conflicts with the self-evident metaphysical truth that changeable being cannot be uncaused and self-sufficient In a

word, the study of atheistic theories of metaphysics furnishes us with a proof, by *reductio ad absurdum,* that God exists; since those systems that deny God are logically compelled to make reality unintelligible. There are, however, a number of positive grounds for admitting the existence of God, and we shall now consider some of these.

Metaphysical Systems that Affirm God

The metaphysical systems of such thinkers as Plato, Aristotle, Plotinus, St Thomas, Descartes, Leibniz, are all theistic, for despite their differences they all agree that the changeable universe of which we have direct experience is not self-sufficient, but depends on an infinite intelligent Being distinct from itself, which is what men commonly mean by the term "God"

Anaxagoras seems to have been the first Greek philosopher to distinguish clearly between the universe and God According to him, God is an infinite all-knowing Mind, who has power over all things and is the cause of the process of change that has resulted in the orderly universe we know Socrates, arguing from the order in the universe, affirmed the existence of God as the Intelligent Cause of this order and a beneficent Providence ordering all things with a view to human well-being. It is Plato, however, who gave to the philosophical knowledge of God the range and completeness that entitled it to rank thenceforth as a department of philosophy He formulated with great profundity most of the classical arguments for the existence of God He conceived of God as an efficient cause, a "Demiurge," who causes things in the material universe to participate in the timeless Forms or Ideas and directs all things for the best with supreme wisdom and power The Demiurge is not a creator in the strict sense, for the primary matter (*"chora"*) that is the featureless substratum of the material universe is not dependent on him for its existence, but is given from eternity. Furthermore, Plato seems to have conceived of the Demiurge, who is the supreme efficient cause of the universe, as distinct from the Idea of Good, its supreme final cause and the pattern according to which it is made He affirms, however, that the Idea of Good is "the cause of all that is right and beautiful in all things, producing in the visible world light and the lord of light, and being itself lord in the intelligible world and the giver of truth and reason." Its distinguishing characteristic, says A E Taylor,

is that it is the transcendent source of all the reality and intelligibility of everything other than itself, and consequently it is not very different from the Christian conception of God. Thus Plato attributes some of the characteristics of the Deity to the Demiurge and others to the Idea of Good, without settling the question of the relation between the two, and this unresolved dualism is the main weakness of his natural theology

Although Aristotle set out the proofs of the existence of God with greater exactness than Plato, his conception of God was in certain respects inferior In Aristotle's philosophy, God is Pure Actuality, Supreme and Unchangeable Perfection, Pure Thought eternally engaged in thinking Itself God is the First Cause of the universe, not as an efficient cause that acts on it, but as a final cause, the Supreme Good towards which it tends. He has no knowledge of particular things or events, because such matters are beneath the notice of Supreme Intelligence Hence He cannot be said to exercise any Providence with regard to the universe The deficiencies of Aristotle's natural theology were mainly due to his failure to arrive at the notion of creation Like Plato, he held that God and the material universe are both given from eternity, so that material things are not dependent on God for the whole of their reality, but only for the ordered dynamism of their evolution

St Thomas, employing the metaphysical principles of Aristotle, established the existence of God as the Subsistent Being upon whom all other things depend for the whole of their reality In this conception of God, the dualism of Plato is done away with, for God is both the Efficient Cause of the universe and the Supreme Good towards which it tends Aristotle's difficulty—that the sublimity of the Divine contemplation would be incompatible with the exercise of a particular Providence—is removed, for although the primary object of the Divine knowledge is God Himself, in knowing Himself God knows the creative decree that confers existence on particular things and knows particular things in this decree As Gilson has pointed out, St Thomas was able to construct a more coherent and profound natural theology than the Greeks because his metaphysics is fundamentally existential For St Thomas the primary characteristic of the things we know is that they exist, in each thing, it is the existence that causes it both to be and to be what it is

Yet existence is not included in the definition of any of them—each of them possesses existence, but none of them can be said to be its own existence The existence of such a world necessarily implies the existence of a Being who is His own existence Such a Being will not be this or that particular kind of being, but an infinite act of Self-Existence, as a real horse is a subsistent horse, so God is a Subsistent Existence, *ipsum esse subsistens*

Since the natural theology of St Thomas is sounder than that of such thinkers as Descartes or Leibniz, we shall in establishing the existence of God make use of some of the proofs that he has set out in the *Summa Theologica*.

The human mind is powerful enough to be able to affirm with absolute certainty that the universe really exists, that it consists of a number of beings, that these beings are subject to change, and are ruled by law in the changes they undergo In other words, the world is real, not an illusion, this reality is not one, but manifold, it consists of beings, of things that possess real existence and are not mere phases in a process of becoming, these things are subject to change, as is particularly evident from the fact that many of them come into existence and afterwards cease to exist, finally, the changes in the universe are not haphazard, but take place in an orderly manner, in accordance with law. The Kantian may dismiss as naive dogmatism the assertion that all these things can be known by the human mind with absolute certainty, we have not the space to deal here with Kant's fundamental misconception of the nature of knowledge, and it must suffice to point out that the truths we have mentioned are accepted as certain by all men except a few philosophers (and even by these philosophers when they are not philosophizing), and they constitute the assumptions that the scientist accepts without question

The proof that God exists may be formulated thus Real being, as we find it in the universe, is (i) changeable, (ii) contingent, (iii) manifold, (iv) governed by law in the changes that it causes and undergoes But such being can exist only in dependence on a Being that is (i) unchangeable, (ii) necessary, (iii) one, (iv) intelligent, and a Being of this kind is what is meant by the term "God" Let us consider each of these characteristics of the universe in turn

First, the being of the universe is changeable All things are subject to local movement, and many of them to qualitative and quantitative change the heavenly bodies move in their orbits, there is motion even in the molecules of solids, things undergo changes of temperature, plants and animals increase in size A body that undergoes change cannot be the total cause of that change, for when it changes it acquires a new mode of being that it did not possess before, and a thing cannot confer on itself a mode of being that it previously lacked, the change must then be caused in it by some other being If this other being is itself subject to change, it must itself be dependent on another being for the changes that it undergoes Even if the series of such changeable causes of change were prolonged to infinity, change would still not be adequately accounted for, because when we multiply such causes to infinity we merely multiply to infinity the inadequacy of each to account for the change of which it is the subject There must then be an ultimate cause of change that is itself not subject to change, and this is one way of describing God

Secondly, the being of the universe is contingent There is not one being in the universe of which we can affirm that it must exist, every being in the universe does exist, but we can see that it is quite possible that it should be non-existent A chemical compound, a tree, an animal, a man, that exists today did not exist a year ago, and some of these will be non-existent in a few years' time Such beings are true beings while they exist, they would be true beings even if they were merely a complex assortment of atoms, and they are more than that But their being is contingent, their grip on existence is transitory, and after a time (apart from the case of the human soul) they cease to be.

If every being in the universe is contingent, then the whole universe, which is nothing more than the well-ordered multitude of such beings, must also be contingent the universe does exist, but it could just as well be non-existent In other words, it does not possess within itself the sufficient reason for its possession of existence Since there must be such a sufficient reason, it must be found in some being distinct from the universe, on which the universe depends for its existence, and ultimately in some being that is not contingent but necessary, existing because

He must exist, because existence is of His very nature; and such a being corresponds to the ordinary notion of God.

Thirdly, the being of the universe is manifold—the universe is not one being but a multitude of distinct beings, which differ from one another in many ways, but all possess real existence This basic similarity, constituted by the fact that all the beings in the universe are beings, must have a sufficient reason. Such a sufficient reason cannot be found in the multitude of beings themselves, for each of them is wholly distinct from every other, and things that are wholly distinct from one another cannot be a sufficient reason for the unity that exists among them. It is clear, for example, that the resemblance between all the human beings now alive is not sufficiently accounted for by these human beings themselves, and we must seek an explanation of it in some factor distinct from them, viz., the original pair of ancestors from whom they are all descended. Another application of the principle is the evolutionist argument from homology, wherein it is urged that the only adequate explanation of the similarity of basic structure in various organisms is their descent from a common ancestor, although the argument is unsound, the principle on which it is based is perfectly valid, viz, that when a number of different things are similar, the similarity must be accounted for by some cause distinct from the things themselves Now the beings in the universe have this feature in common, that they are all beings The only adequate explanation of this similarity is that they all proceed from one Supreme Being, whose nature can best be described by saying that He is the fullness of Being. The effect must resemble its cause, and each thing in the universe resembles Him by the fact that it exists or is a being, this common resemblance of all things to the one Supreme Being is the reason why the multitude of beings in the universe are fundamentally similar to one another Such a Being, one, supreme, and self-existent, who confers existence on all the beings in the universe, is what men commonly mean by God

Finally, the changes that occur in the universe are orderly, or governed by law Since order is the hallmark of intelligence and law is inconceivable without a lawgiver, we must conclude that the universe depends on an intelligent Cause This cause is clearly distinct from material things, which show no signs of

intelligence, and from the human mind, which does not create the order but discovers it. It is then a supra-mundane Intelligence.

To see more clearly why the order in the universe implies the existence of an intelligent Cause of the universe, let us consider the changes that occur when a hen's egg is hatched. The character and tempo of these changes is so determined that the normal result is a well-proportioned chicken, with wings, legs, beak, etc., in the right place. Monsters are the exception; the normal chicken is the rule. Moreover, since even monsters are chickens, however deformed, we may say that if the hen's egg develops, it will always develop into a chicken; it is quite certain that it will not develop into a cow or a crocodile. To explain the determinate character of the changes in the fertilized egg, it is not enough to point to the structure found in the egg itself, for we shall then have to explain why the fertilized egg has this particular structure. It is not enough to say that the egg possesses this structure because it belongs to the nature of the hen to produce such an egg. For once again, we have to explain why it belongs to the nature of the hen to produce such an egg. And the only intelligible answer to this question is that the hen lays an egg of this kind *in order to* produce a chicken. In other words, the bodily structure of the chicken yet to be formed determines the structure of the egg and consequently the character of the changes that take place in the egg. The chicken, although it does not yet exist in physical reality, exercises causality with regard to the egg, determining it to be what it is. But in order to exercise causality, the chicken must exist in some way, for what does not exist cannot exercise causality. Since it does not exist in physical reality, it must exist mentally, i.e., as an object of knowledge in the mind of an efficient cause. The chicken that is yet to be formed must exist in a manner analogous to the existence of the plan that guides the builder when he is putting up a house. The only mind in which it can exist in this way is that of some supra-mundane Cause, for the hen is blissfully ignorant of what goes on during incubation, and eggs develop into chickens independently of the human mind.

Accordingly, from the fact that the changes in the universe are directed to predetermined ends, we infer that these ends

are known to an intelligent Cause, who is distinct from the universe. It should be noted, however, that His guidance of these changes does not require any special intervention, but is sufficiently ensured by the obedience of all things to the laws inherent in their natures Knowing each nature, He knows the end to which it is directed, and by bringing it into existence, He directs it to that end.

If it be argued that the order in the visible universe is sufficiently accounted for by a finite intelligence, we shall reply first that not many who admit the existence of a finite supramundane intelligence will deny the existence of an Infinite Intelligence However, the difficulty may be disposed of directly by the consideration that a finite intelligence cannot account for his own existence, but must depend on some intelligence higher than himself, and ultimately on an Infinite Intelligence Since the object of the intellect is being, and the capacity of the intellect is unlimited so far as its object is concerned, a finite intelligence cannot achieve its end in the contemplation of itself, but only in the contemplation of Infinite Being It must then be directed by its nature to the Infinite Being, and the ultimate cause of this direction must be the Supreme Intelligence, who is Infinite Being, and is not directed to any end beyond Himself

A Supreme Intelligence, who is the ultimate cause of the order in the changes that take place in the universe, is what we commonly mean by God

We may therefore sum up the theistic account of the nature of reality as follows There are two kinds of reality—the manifold, changeable reality of the universe, and a Supreme Unchangeable Reality, on whom the universe depends for its existence This Unchangeable Reality is Self-sufficient, Necessary Being, and Infinite Intelligence Contemplating His Infinite Being, He contemplates at the same time all the possible modes of being that it is within His power to bring into existence He freely wills to confer existence on a certain number of these, so as to create a finite, ordered universe, a universe that depends for the whole of its actuality upon His will The universe is therefore contingent being, and since we can deduce only what is necessary, the universe cannot be deduced from the Being of God This supremely perfect Cause is both transcendent and immanent to the universe He is transcendent, because He

exceeds it by the infinity of His perfections. He *is* His own existence, where as all other things *receive* their existence from Him. He is immanent, because He is in each thing conserving it in existence and concurring with it by His action in all its actions.

It is sometimes urged that an unchangeable God would be static and inactive, and consequently less perfect than a changeable God, who would be active and dynamic. This objection is based on an anthropomorphic conception of God. It is more perfect for *man* to be changing, rather than unchanging, but this is because man comes into existence in a relatively imperfect state and can attain his full perfection only by exercising his powers of activity and undergoing change. God, on the other hand, is infinitely perfect, and so there is no further perfection He can acquire. He cannot change, because He is the fullness of Being, and change implies that a thing receives a mode of being which it did not possess before. This immutability, however, does not imply inactivity on the part of God. Since the activity of a being corresponds to its perfection, God must be infinitely active, or rather, He is infinite activity, activity in which there is no trace of the imperfection of change.

In the theistic conception of reality, the changeable universe becomes intelligible. Becoming or change can be understood only in terms of being, and changeable being only in terms of Unchangeable Being. Any other explanation puts us in the dilemma of either denying the reality of change, with Parmenides, or reducing all reality to a process of change, with Heraclitus.

In establishing the existence of God, we have dealt with the first and most important of the three problems that concern us, and we have laid the metaphysical foundation for our inquiry into the other two, viz., the origin of life, and the origin of the different forms of life.

PART II

THE ORIGIN OF LIFE

THE ORIGIN OF LIFE

BEFORE we discuss the problem of the origin of life on earth, we have to consider what life is and in what way the principal forms of life differ from one another Accordingly we shall deal with the subject under these three heads 1. In what way does a living body differ from a body devoid of life? 2. In what way do the three principal forms of life—plant, animal, human—differ from one another? 3 How is the origin of life to be explained?

1

IN WHAT WAY DOES A LIVING BODY DIFFER FROM ONE DEVOID OF LIFE?

SINCE an evolutionary philosophy does not admit the existence of any cause extrinsic to the universe, those who adopt a system of this kind generally minimize the difference between living and non-living bodies. A few, like Bergson and Lloyd Morgan, hold that with the evolution of life a completely new reality appeared on earth, of a higher order than those already in existence. The majority, however, dislike a theory that so plainly contradicts the principle of causality, and they endeavour to show that there is no abrupt cleavage between living and non-living matter. Sometimes they appeal to "the principle of continuity," according to which "there are no big jumps in Nature" (*Natura non facit saltum*). This so-called "principle," we may remark at once, is not self-evident, for no reason can be given why there must be no jumps in Nature, nor is it an inductive general law, for, as we shall see, there are many facts that contradict it.

The theories put forward by those evolutionary philosophers who maintain that living matter is continuous with non-living may be divided into two classes—Panpsychism and Mechanism. According to Panpsychism, what we call inanimate matter is really endowed with a rudimentary form of life, but this life manifests itself in observable vital phenomena only when particles of "inanimate" matter coalesce to form very complex chemical compounds. Haeckel, as we have seen, holds a form of Panpsychism, and J. B. S. Haldane, after pointing out that science is committed to the attempt to unify human experience by explaining the complex in terms of the simple, goes on to express the opinion that "if we ever explain life and mind in terms of atoms, we shall have to attribute to the atoms the same

nature as that of minds or constituents of minds, such as sensations."[1]

Mechanism takes the opposite line, and denies that vital phenomena are anything more than a very complex form of the physical and chemical activities found in non-living matter According to this theory, the living body is an extremely complicated machine, it is not one entity, but a number of distinct entities juxtaposed and acting on one another by means of their physical and chemical forces, it is a combination of many complex chemical compounds, and its vital activities are simply the sum-total of the activities of these different compounds F le Dantec, an exponent of the theory, puts it in a nutshell when he writes "Between life and death, the difference is of the same order as that which exists between a phenol and a sulphate, or between an electrified body and a neutral body."[2] The Mechanist admits that because of the extreme complexity of vital phenomena, we shall probably never succeed in expressing them in a number of chemical and physical formulae; but he holds that if we could discover the formulae for all the elements of a vital action we should have a complete insight into the nature of the vital action as a whole, just as we have an adequate explanation of the motion of a motor-car when we know the physical and chemical formulae for the explosion of the petrol and the manner in which the force thus generated is communicated to the wheels

In refutation of Panpsychism it is enough to point out that there is not the slightest evidence that inanimate matter possesses any form of vital activity, however rudimentary The theory is a mere gratuitous assertion, and there is no need to bring forward positive arguments to disprove it We may mention, however, that it cannot explain how the manifold life of a multitude of atomic particles could combine to form the unitary life of the complex organism.

The Mechanist attempt to explain life in terms of the physical and chemical forces of inanimate matter is a failure, for, although living bodies are composed of the same chemical elements as non-living, and are subject to the same chemical and physical laws (e g, the law of the conservation of energy), they

[1]The Causes of Evolution, 2nd Edn, Longmans, London, 1935, p 157
[2]The Nature and Origin of Life (Tr S Dewey), Hodder and Stoughton, London, 1907, p 5

manifest a number of properties that make it impossible to reduce them to the level of mere complex chemical compounds or machines

In the first place, even the simplest organism is far more complex in structure than any non-living body, consisting as it does of a vast number of different molecules, some of which contain thousands of atoms Secondly, the inanimate chemical compound is formed by elements differing in kind from itself, whereas the living body is produced by another body of the same kind Thirdly, the non-living body is fully perfect as soon as it is formed, whereas the living body comes into existence in an imperfect state and only gradually reaches its full perfection; that is why the non-living body is in a state of stable equilibrium, while the living body is in a state of unstable equilibrium, constantly undergoing chemical change "Life," to quote Cuvier, "is the faculty possessed by certain corporeal combinations of enduring for a determinate time under a determinate form, altering ceaselessly a part of the surrounding substances to form their own, and rendering to the elements portions of their own substance Life is a vortex, in which the form is more important than the matter "[3]

The vital functions found in living bodies and completely absent from non-living matter are thus catalogued by Roux 1 the ingestion of foreign substances that are to serve as food; 2 the assimilation of these substances, 3 the transformation of these substances for employment in the functioning of the living thing; 4 the excretion of useless or harmful residues, 5 the replacement of substance used, so that the living thing keeps itself entirely or almost entirely unchanged; 6. growth, by the over-compensation of losses, 7 irritability, or the power to respond by movement or change to excitation received, 8 the power to divide itself and thereby multiply (reproduction), 9 the transmission by the parent of its properties to the offspring (heredity) Furthermore, each of these functions is self-regulating, or more correctly, the organism has the power of regulating these functions so that they tend to promote its own welfare

[3]Quoted by Vialleton, L'Origine des Etres Vivants, Paris, Plon, 1929, p 303

In its vital activities the living body makes use of the same forms of energy as are found in non-living matter, but these activities tend to promote the well-being of the living body itself In every living thing, in other words, there is internal finality or purposiveness, manifested in its natural tendency to live and endure Structure and function concur to achieve this result with a success that has been constantly repeated since life first appeared There is harmony between structure and function—every organ is adapted to its function, and the exercise of this function is normally sufficient to secure the well-being of the organism This does not mean that everything in the organism has a purpose, for some parts are by-products of the process of development (e g , mammae in males), but the organs employed in vital activity are adapted to their function, and these functions are adapted to the well-being of the living body This tendency of vital activity to promote the well-being of the agent from which it proceeds is its essential and distinctive characteristic, a characteristic to which the Scholastic philosophers have given the name of "immanence" Accordingly, they define life as "the exercise of immanent activity," that is, the exercise of activity that tends to perfect the agent from which it proceeds

This definition of life implies that the living body is a single source of activity, and therefore a single substance, not a number of distinct substances In other words, the parts of the living body are not separate substances, but are merely parts of a single substance, the complete organism The truth of this conception is clear from the fact that the activities of the various parts are primarily ordained to the well-being of the whole organism and promote the well-being of the parts themselves only in so far as they are parts of the organism

The unitary or organismal conception of life has been ably explained and defended by E. S Russell "In the living thing," he writes, "there are no completely separable or independent parts, if we distinguish separate units or components it is at the cost of artificially simplifying our definition of them by abstracting from their continuing relations with the activity of the organism as a whole It is primarily because the parts or constituents so distinguished are to a large extent abstract that it is impossible fully to reconstitute from them the whole from which they themselves are derived by the process of analytical

abstraction The unity of the organism is accordingly not decomposable without loss and cannot be resynthesized in its original completeness from the abstract components distinguished by analysis We may sum this up in the following cardinal law of biological method The activity of the whole cannot be fully explained in terms of the activity of the parts isolated by analysis and it can be the less explained the more abstract are the parts distinguished The organs of the body form one harmonious and indissoluble whole D'Arcy Thompson writes 'Muscle and bone, for instance, are inseparably associated and connected, they are moulded with one another, they come into being together, and act and react together We may study them apart, but it is as a concession to our weakness and to the narrow outlook of our minds We see, dimly perhaps, but yet with all the assurance of conviction, that between muscle and bone there can be no change in the one but it is correlated with change in the other, that through and through they are linked in indissoluble association, that they are only separate entities in this limited and subordinate sense, that they are parts of a whole, which, when it loses this composite integrity, ceases to exist The biologist, as well as the philosopher, learns to recognize that the whole is not merely the sum of its parts It is this, and much more than this For it is not a bundle of parts, but an organization of parts, of parts in their mutual arrangement, fitting with one another in what Aristotle calls a single and indivisible principle of unity' "[4]

The living body is one entity Each organism is a closed system, composed of heterogeneous parts and existing as an independent substance, it constructs its own organs by action from within and is not made of parts fashioned separately and assembled by some external agent Thus the embryo, which gets most of its mass from the external world, imposes on this matter the form it has received from its parents In the higher forms of life, this process of growth involves the multiplication of cells, but the unity of the organism is not destroyed, for the cells are not independent organisms but only parts subordinate to the whole "If any radical conclusion from the immense amount of investigation of the elementary phenomena of develop-

[4]The Interpretation of Development and Heredity, Clarendon Press, Oxford, 1930, p 146

ment be justified," writes F. R Lillie, "this is that the cells are subordinate to the organism which produces them, and makes them large or small, of a slow or rapid rate of division, causes them to divide, now in this direction, now in that, and in all respects so disposes them that the latent being comes to full expression We see this in the adaptiveness of the process of cleavage in the ovum, in the regeneration of the starving planarian constantly suffering a diminution in the number of its cells while its structure is increasing in complexity, in 'regulation,' and in all cases of morphallaxis, whether in a protozoon or a metazoon, it is an individual, not by virtue of the co-operation of countless lesser individualities, but an individual that produces these lesser individualities on which its full expression depends "[5]

To sum up, the living body is a single substance and is capable of a number of kinds of immanent activity of which a non-living body or collection of bodies (a machine) is incapable In performing these actions, the living body does indeed employ physical and chemical energy derived from non-living matter, but it uses this energy to produce results totally different from those that the same energy would have produced in non-living matter Since the living body possesses all the forms of activity found in non-living matter, and the modes of immanent activity proper to itself, we conclude that it belongs to a higher order of being than the non-living body, since the nature of a thing is revealed by the kinds of activity of which it is capable

Life is therefore not merely a specific characteristic, analogous to the characteristics by which one plant is differentiated from another, but is a generic characteristic, and living bodies form a distinct world, essentially superior to the world of non-living matter It follows as a corollary to this that biology is a distinct science and is not reducible, even in principle, to chemistry and physics It is of course obliged to take account of the findings of these sciences where they are relevant to its own researches, but it is a substantive science, not an amalgam of departments of chemistry and physics, and it must formulate and solve its problems in its own distinctive way

[5]Journ Exper Zool iii, 1906, p 252 Quoted in Russell, op cit, p 243

2

IN WHAT WAY DO THE THREE PRINCIPAL FORMS OF LIFE DIFFER FROM ONE ANOTHER?

EVOLUTIONARY philosophers generally tend to minimize the distinction between the three kingdoms into which the living world is commonly divided, they emphasize the difficulty of determining whether certain low forms of life are plants or animals, and they exaggerate the similarity between the psychical life of the animals and that of man Darwin has provided us with the classical example of a humanized animal psychology in *The Descent of Man,* and Loeb has attempted to explain animal behaviour in terms of the tropisms found in plants Loeb's theory is a Mechanist *'tour de force'* and may be summed up thus human behaviour is a matter of conditioned reflexes such as we find in the lower animals, reflex action is reducible to tropisms such as we find in plants, and plant tropisms are a matter of physics and chemistry Loeb's theory, which may be described as a series of "nothing but's," ignores a host of facts that contradict it, but it must suffice here to point out the falsity of his initial assumption—that plant tropisms can be explained by the action of physical and chemical forces alone Such forces can provide no reason for the opposite direction of these tropisms in the stem and the root, such tropisms can be explained only if we admit that the plant is a single living body which provides for its well-being by moving some of its parts in the direction of light and air, and other parts in the direction of earth and water

There is no need for us to prove at length that life is found at three levels, for the facts are evident enough On the lowest level we have plant life, of which the principal functions are the absorption of food, growth, and reproduction On the next level is sentient life, the life of the brute animals, which consists of the three functions found in plant life, together with sense-

knowledge of various kinds, appetite, and motor activity. The theory of Descartes that the brute animals are mere automata devoid of consciousness, and the theory of J B Watson, that animal behaviour can be adequately explained without admitting consciousness, are obviously false and do not stand in need of detailed refutation. To assert, as these theories do, that the movements of a cat stalking a bird, or of a dog heading sheep, can be adequately explained by the psychologist without admitting knowledge in the animal, is to talk nonsense

Because it is difficult to determine whether some low forms of life (e g, certain bacteria) are plants or animals, some have concluded that there is continuity between the plant and animal kingdoms This conclusion is quite unwarranted, for the criterion by which one kingdom is distinguished from the other is clear and well-defined—if an organism has the power of knowledge, it is an animal, if it lacks this power, it is a plant The two kingdoms are perfectly distinct and we can affirm with complete certainty that these low forms of life must belong to one or the other, for they must be capable of knowledge or incapable of knowledge, the terms are contradictory and exclude the possibility of a middle term These organisms must then be either plants or animals, because an intermediate form is impossible The difficulty of determining by observation whether or not they are capable of knowledge may perplex the scientist, who aspires to a complete classification of the living world down to the lowest species, but it is only by a gross confusion of thought that it can be regarded as constituting a serious problem for the philosopher.

On the highest level, we have human life, which consists of all the activities found in plants and animals, together with abstract thought and volition To bridge the gap between man and the lower animals, Darwin and his followers have given an anthropomorphic account of animal psychology, attributing intelligence to the brutes "Intelligence" is an ambiguous term, but if we take it as the power of forming abstract or universal concepts, then the brute animals do not possess it The lower animals, as Hans Driesch remarks, act in accordance with the principles of contradiction and causality, but without consciously possessing these principles Similarly, the spider and the honey-bee build structures in accordance with the principles of higher

mathematics, but from the fact that they always embody these principles in the same concrete form, we are entitled to conclude that they have no knowledge of the principles themselves. Diversity in the concrete expression of a general idea is the natural result of the understanding of such an idea, as we see from the great variety of dwellings that fall within the category of "house."

The sagacity of such animals as dogs and apes can be adequately accounted for without attributing intelligence to them. The animal has the power to learn by experience, his sense memory enabling him to connect an item of present experience with another item that was associated with it in previous experience;[1] he can also, independently of previous experience, perceive certain groups of objects as concrete wholes—he perceives them as related without forming any abstract idea of relation. Since we have no direct knowledge of the workings of the animal mind, it is sometimes difficult to give a completely satisfactory explanation, in terms of sense-knowledge, of an instance of animal sagacity, but it will often be possible to devise an experiment involving a slightly different application of the same general principle to show that in the case in question the animal had no understanding of the principle itself. When we compare objectively the achievements of Kohler's apes and those of the most primitive man, we can hardly fail to see the enormous chasm which separates the brute from the rational being.

The Darwinians themselves implicitly admit the truth of our contention that there is a clear line of demarcation between man and the lower animals, for when an archaeologist unearths some primitive tools, they never think of attributing these to any other animal than man. Man is the only rational animal; he alone has the power of forming universal ideas and of reasoning, and from this power as from a source flow all his other distinctively human characteristics: morality, religious sense, aesthetic sense, language, the aptitude for scientific and cultural progress. The fact that the brutes lack all these derivatives of rationality is further evidence that they are devoid of reason itself.

[1]Cf. Wm. James, The Principles of Psychology, Macmillan, London, 1890, Vol. II, pp. 348-360.

The other line of attack taken by evolutionary philosophy is to reduce the mental life of man to brute level by denying the reality of universal ideas and explaining human thought as the association of sense-images This theory, known variously as Empiricism, Sensism, or Associationism, cannot be reconciled with the data obtained by an objective examination of human consciousness

In the first place, the sense-image is quite distinct from the abstract or universal idea. The sense-image, however vague and ill-defined, is always concrete and particular, representing only one object, e g , this cow, of this definite colour and size The idea is abstract and universal, expressing the essential features of the object it represents apart from its particularizing characteristics, and accurately representing all the individuals that embody these essential features, however diversified they may be For example, the *idea* "man," which means "an animal endowed with the power of forming abstract ideas," accurately represents the babe in arms and the bewhiskered octogenarian, the Patagonian and the pigmy, the philosopher and the village simpleton, the *image* of "man," on the other hand, represents only a single individual, "this man, with these features, here and now present in my imagination" The more closely we scrutinize an image, the more clearly do we see that it is particular, the more closely we scrutinize an idea, the more clearly do we see that it is universal Furthermore, there are some objects of which we can form no true image, e g , a regular myriagon—a polygon having ten thousand equal sides, whereas we can form the idea of such an object without any difficulty, discussing, for example, the size of its interior angles

Secondly, if all our knowledge were reduced to the level of sense-experience, such concepts as "right," "duty," "virtue" would be meaningless, for it is impossible to assign a concrete object of sense-experience of which these concepts would be the representation, and if such concepts had no meaning, ethical speculation would be a waste of time, and genuine moral judgements would be impossible

Thirdly, Sensism is incompatible with the fact that we recognize objective necessity in mathematical and other truths It is a fact, for example, that we perceive that in every triangle the angles must together be equal to two right angles, so that we

can affirm that this will necessarily be the case in a triangle yet to be constructed The Sensist is compelled by his theory to deny this fact, for him the only knowledge we have of triangles consists of the factual information, summarized in a general statement, which has been obtained by measuring various figures that are approximately triangular Mathematical propositions, according to the Sensist, are only approximately true and we cannot be certain that we shall never experience an exception to them

Finally, Sensism is self-contradictory, for while denying the existence of universal concepts, it consists, like every other theory, of a number of universal statements, such as, "There are no universal concepts," "All human knowledge is sense-knowledge", and in order to make universal statements, we have to employ universal concepts

We conclude, therefore, that man possesses intellectual knowledge, which is quite distinct from the sense-knowledge that he has in common with the lower animals As animal life is more perfect than plant life, so human life is more perfect than mere animal life

Thus life is found at three distinct levels, or, to put it in another way, living bodies form three separate kingdoms, and these three kingdoms are cut off from one another so sharply that there cannot be an intermediate form linking one with another An organism must be either capable or incapable of knowledge—it must be either an animal or a plant, and if it is an animal, it must be either capable or incapable of intellectual knowledge—it must be either a man or a brute Irrationalism is now so fashionable that many will reject these statements as unphilosophical dogmatism We hold, however, that the human intellect is capable of sufficient insight into the nature of reality to justify our assent to these conclusions drawn from the facts of experience, and that it would be an unwarranted mistrust of our reason if we were to admit that the rose may be capable of feeling, or the cow of abstract thought

3

HOW IS THE ORIGIN OF LIFE TO BE EXPLAINED?

We shall first discuss the origin of life in general and then the origin of the three separate forms of life.

It is scientifically certain that the earth was at one time too hot to support organic life, and consequently organic life on earth must have had a beginning The question is: How did it begin?

Some have suggested that living germs reached the earth from the distant regions of space, being either conveyed by meteorites (Helmholtz, Lord Kelvin), or propelled by the pressure of radiation (Arrhenius) It seems, however, that such germs could not possibly survive the hazards of this journey the extreme cold of space, the intense short-wave radiations from which we are shielded by the atmosphere, the action of the ultra-violet rays given off by the meteorite in its passage through the atmosphere, or the impact of the meteorite as it hit the earth. In any case, even if the living germ were successful in evading all these destructive forces, the question would remain How did it come into existence? In a word, these theories do not bring us any nearer the solution of our problem and they need detain us no further

Disregarding these hypotheses of "transportation" and admitting that organic life arose on the face of the earth, we may reasonably assume that the first living bodies were formed out of inanimate matter already in existence The question is How was this transformation effected? Some hold that life originated by spontaneous generation · particles of non-living matter would have combined of themselves to form the complex chemical compound that we call the living organism In this theory, the origin of life would be adequately accounted for by the interplay of forces inherent in inorganic matter Others, on

the contrary, maintain that inorganic matter is incapable of effecting such a transformation, and that we must attribute the origin of life to the direct action of God, who by his "Fiat" would have transformed inanimate matter into the living organism

Since the evolutionary philosopher does not admit God, he has no alternative but to hold the theory of spontaneous generation The usual line of argument is to admit that spontaneous generation does not now take place, but to assert that it could have taken place, and must have taken place, under the widely different conditions prevailing when life began At a given moment in the history of the earth, the interaction of chemical and physical forces would have caused the formation of organic compounds and these would have gradually combined to form living protoplasm "If it were given me," wrote T H Huxley, "to look beyond the abyss of geologically recorded time to the still more remote period when the earth was passing through physical and chemical conditions which it can no more see again than a man can recall his infancy, I should expect to be a witness of the evolution of living protoplasm from not living matter I should expect to see it appear under forms of great simplicity, like the existing fungi but I beg you once more to recollect that I have no right to call my opinion anything but an act of philosophical faith"[1] Herbert Spencer went further and affirmed spontaneous generation as a fact "At a remote period in the past," he wrote, "when the temperature of the surface of the earth was much higher than at present, and other physical conditions were unlike those we know, inorganic matter, through successive complications, gave origin to organic matter"[2] What the "successive complications" were, he did not venture to say E S Goodrich was more explicit, and spoke of the emergence, "possibly with the help of some catalytic substance," of "a self-repairing compound or mixture" that would outlast other compounds, give rise to "a nicely balanced mixture of anabolic and catabolic proteins," and so "finally become elaborated into protoplasm"[3] More recently,

[1]Biogenesis and Abiogenesis, in Critiques and Addresses, Macmillan, London, 1873, pp 238-239
[2]Nineteenth Century, May, 1886 Quoted in B Windle, Vitalism and Scholasticism, Sands, London, p 135
[3]Living Organisms, Clarendon Press, Oxford, 1924, p 24

Professor J Johnstone wrote "We do not know what were these conditions in which the first forms of life originated, for they do not appear to have recurred, and it has been impossible to reproduce them experimentally Present physical conceptions appear to suggest that this origin of living things occurred, of itself, simply as 'a fortuitous concourse of atoms,' that is, as a highly improbable physical event It is not 'impossible,' and though its probability is extraordinarily small, that is not an *a priori* reason for refusing to contemplate the possibility of the event We incline to think of such a primary life material as similar to the 'undifferentiated protoplasm' of the lower organisms "[4] In this view, the origin of life would be due to chance, with the odds, say, a million to one against We may note in passing that "undifferentiated protoplasm" is a figment of the scientific imagination, since all real protoplasm is highly differentiated

T H Morgan, the eminent geneticist, has put very clearly the principal difficulty that any theory of spontaneous generation has to meet "No one would maintain," he wrote, "that so complex a mechanism as that of a living organism could suddenly appear by the accidental coming together of the materials of which it is at present composed This is as inconceivable as that an automobile could develop through the chance meeting of wood, rubber, oil and gasoline, or to use Paley's old image, that a watch could be produced by the accidental accumulation of pieces of iron The parts of the automobile and of the watch have been brought together under the direction of a human agent, but what has brought the parts of the organism together? The implication in this question is that there must have been a directing agent of some sort, since by chance, such a fortuitous combination is inconceivable The statement ignores certain properties of living materials that put the two problems in a different light These are the property of growth, by which living matter can increase indefinitely in volume, the property of multiplication, by which a given sample may duplicate itself without limit, and the possibility of changes in the material that furnish new stable conditions "[5] In this passage, Morgan

[4]Entropy and Evolution, art in Philosophy, 1932, p 293. Quoted in H V Gill, Fact and Fiction in Modern Science, Gill, Dublin, 1943, p 94

[5]Evolution and Genetics, Princeton U P, 1925, p 144

is guilty of an obvious fallacy After admitting, quite rightly, that it is absurd to attribute the origin of the living organism to chance, he goes on to say that the formation of the complex organism is sufficiently explained by its capacity to grow, reproduce itself and adapt itself to new conditions, ignoring the point at issue, which is to explain the formation of the organism that possesses these powers It is as if one were to explain the *manufacture* of a motor-car by pointing to the fact that it serves admirably as a means of transport when the engine, properly cooled and lubricated, is run on petrol, and the driver knows his business The germ-cell, from which the complete organism develops, has a much more complex structure and exhibits a deeper level of purposiveness than a watch or motor-car, and on the evidence available we are entitled to assume that the same is true of the original living organism The germ-cell derives its structure from its parents, but what about the original living organism? To what cause shall we assign the assembling of its parts? The only alternatives are chance, or the action of God Chance cannot account for it, because chance adds nothing positive to the forces of inanimate matter, chance is not a cause but simply the conjunction of an uncoordinated plurality of causes, and an uncoordinated plurality of causes cannot be a sufficient reason for what is a single substance consisting of well-coordinated parts—the living organism The impossibility of accounting for the origin of life by chance becomes particularly evident when we consider the capacity of the organism to perpetuate its type by reproduction, the effects of chance are essentially variable, whereas if we attribute the origin of life to chance, we shall have to attribute to chance an indefinite series of forms essentially identical—all the generations of descendants that have sprung from the original living organism

Since then it is literally absurd to attribute the origin of life to chance, we must attribute it to the action of God, a living efficient cause, who is able to communicate life to inanimate matter This is the Scholastic position

The spontaneous generation of life, according to Scholastic philosophy, is not just highly improbable, but absolutely impossible, because it contradicts the self-evident principle of causality If the living body came into existence through the inter-action of non-living bodies, an effect would have been produced without

a proportionate cause, and this would contradict the principle of causality, according to which it is absolutely impossible that an effect should come into existence without a proportionate cause In this case the cause would not be proportionate to the effect, because the living body, as we have shown, belongs to an essentially higher order of reality than the non-living body by reason of its capacity to exercise immanent activity The theory of spontaneous generation implies that the perfection in virtue of which the living body is superior to non-living matter came into existence without a sufficient reason

We therefore reject the theory of spontaneous generation as completely untenable, and assert that the only rational explanation of the origin of life is to attribute it to the causative action of God If we may be permitted to quote a scientist in a philosophical debate, J Reinke, the eminent botanist, was right when he said "If we assume at all that living creatures once were formed of inorganic matter, as far as I can see, the theory of creation is the only one which satisfies the demands of logic and causality, and so satisfies those of reasonable scientific research."[6]

Considered exclusively as a datum of sense experience, the origin of life would have appeared to the observer as a process of spontaneous generation, for the senses would have recorded nothing more than the change of non-living matter into a living organism However, to an intellect comprehending the nature of the change it would have been evident that the change could have been brought about only by the direct intervention of the First Cause, God

The Divine action would not be creative in the strict sense, but rather formative, for creation is the production of a being according to the whole of its entity, i e, independently of any pre-existing subject-matter, whereas the first living body would have been formed out of non-living matter already in existence. Moreover, since the initial constitution of the natures of things belongs to the order of nature, neither this Divine action nor its effect would have been supernatural or miraculous Haeckel therefore made three mistakes in a single sentence when he

[6]Einleitung in die theoretische Biologie, p 559 Quoted in E Wasmann, Modern Biology and the Theory of Evolution (Tr A M Buchanan), Kegan Paul, London, 1910, p 206

wrote: "If we do not accept the hypothesis of spontaneous generation, we must have recourse to the miracle of a supernatural creation."[7]

As a result of the experiments of Pasteur and others, almost everyone now agrees that spontaneous generation does not take place at the present time *Omne vivum e vivo* is accepted as a biological law It should be noted, however, that this does not entitle the scientist, *qua* scientist, to assert that spontaneous generation was impossible five hundred million years ago, for it is the business of the philosopher, not the scientist, to establish the impossibility of spontaneous generation Nevertheless, the fact that spontaneous generation does not now occur creates a scientific presumption that it did not occur in the past, and the burden of proof lies on those who assert that it did, furthermore, to meet the demands of logic they must give an intelligible explanation of how such a change was brought about When we examine the explanations of those who affirm spontaneous generation, we find that they do little more than make vague references to the very different physical conditions prevailing on earth when life first came into existence What these conditions were, or how they were conducive to the appearance of life, they do not say What, we ask, could have been the chemical or physical conditions, compatible with life, that cannot be reproduced in our laboratories? To this question there is no answer The temperature, for example, could not have been much higher that it is now, or conditions would have been too hot for life to exist It is idle to say, as P E Raymond does, that "chemical combinations may have been brought about which cannot be duplicated on the small scale of the modern experimental laboratory"[8] We want to know what these chemical combinations were, and also why they are more likely to have been produced by the undirected forces of inorganic matter than by the intelligently controlled forces of the modern laboratory

The success of modern chemists in producing certain organic compounds by artificial synthesis is of no help to the theory of spontaneous generation First, these compounds are comparatively simple in structure, whereas the living body contains

[7]Natural History of Creation, Vol I, p 348 Quoted in G B O'Toole, The Case against Evolution, Macmillan, New York, 1925, p 186
[8]Prehistoric Life, Harvard U P, 1939, p 311

substances of immense complexity. Secondly, these compounds are completely devoid of life, the living body is not merely organic matter, it is an organized body, and not only does the organized body consist of many parts, each with its own chemical structure, but these parts are organized from within by a principle that ensures their perfect coordination and the regulation of all their functions for the good of the whole organism In a word, the organized body is alive, whereas the compounds synthesized by the organic chemist are dead Thirdly, even if some chemist formed a living body out of non-living matter (a most improbable hypothesis), this would not establish the possibility of spontaneous generation, because the chemist is an intelligent cause, a living organism, and for spontaneous generation to take place, non-living matter must give rise to life without the intervention of any living agent Finally, it is to be noted that inanimate matter, outside the artificial conditions created by the chemist in the laboratory, is so far from producing a living organism that it does not even produce the relatively simple organic compounds formed by artificial synthesis

We have already referred in passing to the attempt some have made to render the theory of spontaneous generation more plausible by taking as the initial form of life a very simple cell, midway between inanimate organic matter and the complex organism This simple cell is what Haeckel called the *Monera* Research has shown, however, that there are no simple cells, there are only differentiated cells, and these are either parts of the multicellular organism or unicellular organisms, the Protozoa The Protozoa, such as the amoeba, are not simple cells, but complete organisms, morphological types, exercising an independent role and occupying a determinate place in nature "One thing has emerged very clearly from the modern intensive investigation of the Protista," writes E S Russell, "and that is the amazing complexity of organization which can be developed within the confines of a single cell. . As an example of a high degree of intra-cellular organization, let us take the *Diplodinium ecaudatum*, whose structure is thus described by Calkins 'Bars of denser chitinous substance form an internal skeleton; special retractile fibers closing a dorsal and a ventral operculum, other fibrils, functioning as do the nerves of Metazoa, form a complicated coordinating system, cell mouth, cell anus,

and a fixed contractile vesicle or excreting organ, are also present All of these are differentiated parts of one cell for the performance of specific functions, and all perform their functions for the good of the one-celled organism which measures less than 1/260 inch in length Analogous, if not so complete, intracellular differentiations are present in the majority of Infusoria, while many of the flagellates, notably the *Trichonymphidae,* have an almost equally elaborate make-up' "[9] While not all unicellular organisms are so complex as *Diplodinium ecaudatum,* it is certain that nothing remotely resembling Haeckel's *Monera* exists at the present time, and almost equally certain that nothing like it has ever existed As Radl says, Haeckel's *Monera* is an anachronism, it is a pre-scientific concept surviving in the midst of scientific facts that are incompatible with it[10]

Some modern Catholic scientists, e g, Sir Bertram Windle, W R Thompson, have said that St Thomas and the mediaeval Scholastics admitted spontaneous generation as a fact[11] This is incorrect. St Thomas and his contemporaries thought that certain lower forms of life came into existence without being generated by parents of the same species They admitted this, because it seemed to be a fact, they saw maggots appear in decaying flesh and animalculae in stagnant water, seemingly without the intervention of a parent This was a serious difficulty for St Thomas, because he held that living matter is essentially more perfect than non-living, and also that a thing cannot of itself give rise to something more perfect than itself His solution of the difficulty may strike us as rather fanciful, but it had the merit of enabling him to save his philosophical principles He attributed the generation of these lower forms of life to the action of angels, who, using the heavenly bodies as instruments, would turn non-living matter into living organisms This explanation was in harmony with the Aristotelian view then current that the matter of the heavenly bodies is incorruptible and more perfect than earthly matter, and the motion of the heavenly bodies is caused by supra-mundane intelligences For example, in a passage in his work *De*

[9]The Interpretation of Development and Heredity, p 237
[10]The History of Biological Theories, p 143
[11]B Windle, The Church and Science, 3rd Edn, C T S, London, 1928, p 320, W R Thompson, Science and Common Sense, Longmans, London, 1937, p 174

Potentia, St Thomas deals with the difficulty that, since the heavenly bodies consist of non-living matter, they cannot be the cause of life on earth He writes "As St Augustine says, the living substance exceeds in perfection (*prae-eminet*) any non-living substance But a heavenly body is not a living substance, since it is without a soul Therefore the sentient soul, which is a principle of life, cannot be produced by its power . . ." He meets the difficulty, as we have said, by attributing the production of these forms of life to the action of a spiritual cause, thereby saving his philosophical principles, principles that exclude the possibility of true spontaneous generation "To this difficulty we reply that although the heavenly body is not alive, nevertheless it acts by the power of the living substance by which it is moved, whether this substance be an angel or God."[12] It is quite certain, therefore, that St Thomas did not admit the possibility of spontaneous generation as the moderns understand the term.

It is absolutely impossible that inorganic matter should give rise to plant life by spontaneous generation, because this would make the effect more perfect than its cause For the same reason, it is absolutely impossible that plant life should of itself, under the influence of the inorganic environment, give rise to animal life, or that animal life should of itself give rise to human life. Accordingly, we must invoke a special exercise of Divine causality to account for the origin of each of the three forms of life It is pleasant to recall that A. R Wallace, joint author with Darwin of the theory of natural selection, had enough philosophical perspicacity to see the necessity of such a threefold intervention "There are," Wallace wrote, "at least three stages in the development of the organic world when some new cause or power must necessarily have come into action The first stage is the change from inorganic to organic, when the earliest vegetable cell, or the living protoplasm out of which it arose, first appeared The next stage is still more marvellous It is the introduction of sensation or consciousness, constituting the fundamental distinction between the animal and the vegetable kingdoms The third stage is, as we have seen, the existence in man of a number of his most distinctive characteristics and noblest faculties, those which raise him furthest above the brutes and open up possibilities of almost

[12]De Potentia, q 3, art 11, ad 13um

indefinite advancement. . These three distinct stages of progress from the inorganic world of matter and motion up to man, point clearly to an unseen universe—to a world of spirit, to which the world of matter is altogether subordinate"[13]

Professor J B S. Haldane has argued that the passage from animal to human life does not demand any such intervention "Certain of the critics of evolution," he wrote, "have admitted the possibility of fairly large structural or functional changes, but not of such a profound change as the origin of consciousness or reason I sympathise with their attitude, but cannot share it, because it seems to me to rest on a refusal to face certain perfectly amazing facts of everyday life The strangest thing about the origin of consciousness from unconsciousness is not that it happened once in the remote past, but that it happens in the life of every one of us An early human embryo without nervous system or sense-organs, and no occupation but growth, has no more claim to consciousness than a plant—far less than a jellyfish"[14] The same argument is suggested by Father H J T. Johnson when he writes: "The story of the individual in its passage from the embryo to the full-grown man is a record of evolution, is it unreasonable therefore to suppose that this evolution epitomises the history of the human race?"[15]

There is a fallacy in this analogy or parallel that Haldane and Fr Johnson draw between the development of the individual and the supposed evolution of the race, for the individual has an adequate cause, being brought into existence by a parent possessing the same nature as himself, whereas the evolutionary theory of the origin of the race would make human nature the product of natures essentially inferior to itself, i.e, an effect for which there would be no adequate cause The human embryo is a true human being, with the full essential perfection of human nature, although not actually conscious, the embryonic individual has a real capacity for human consciousness, as is clear from the fact that, given normal development, he will be capable of human activity one day, whereas no plant or animal has any such capacity at any stage of its existence

[13]Darwinism, Macmillan, London, 1889, pp 474-476
[14]The Causes of Evolution, pp 4-5
[15]The Bible and the Early History of Mankind, Burns Oates, London, 1943, p 29

Life is an irreducible phenomenon, an ultimate datum of experience It transcends the categories of inanimate matter and any attempt to explain it in terms of inanimate matter or the physical and chemical forces that inanimate matter possesses must end in absurdity The three forms of life found on earth are likewise ultimate and irreducible, and any attempt to explain the higher forms of life in terms of the lower or to derive the higher by natural evolution from the lower necessarily results in misrepresentation of the data of experience.

The assertion that life is irreducibly manifold will be a stumbling-block to many minds Some scientists, setting too much store by the deductive methods of mathematics to which they have grown accustomed, feel there is something unscientific about a reality whose properties cannot all be learned by deduction from a few simple axioms The nature of the living world, however, is not to be learned by deduction along the lines of mathematics but by the biological and philosophical interpretation of the facts of experience, and these facts are not to be deduced but are simply given as facts

It is true that the philosopher must try to make this plurality of living forms intelligible in terms of a higher principle of unity, but his explanation must not deny that the plurality is real nor reduce all living things to a single category Haldane attributes this function of philosophy to science "Science," he says, "is committed to the attempt to unify human experience by explaining the complex in terms of the simple"[16] But by "explaining the complex in terms of the simple" he means "explaining life and mind in terms of atoms," i e , reducing all the forms of life to the level of inanimate matter Haldane's notion that the atom is simple is a Victorian survival, in the light of modern physics, it is no longer tenable Furthermore, not only is the atom, because of its minute size, more difficult to observe than living bodies, it is also philosophically less intelligible than the living body and cannot therefore be the basis of a philosophical explanation of life

If we are to find an explanation of the three forms of life that will satisfy the philosophical demand for unity without denying the real distinction between them or subtracting anything from the reality of each, we must consider them not from

[16]Op cit, p 156-157

below but from above, viz, as reflecting, in varying degrees of perfection, the infinite life of God. In other words, we can meet the intellectual need to unify the data of experience in this field only if we admit that Theism is true and contemplate created reality as receiving its perfection from God, who is the fullness of Infinite Being

Life, as we have seen, consists in immanent activity, i.e, activity that both originates and terminates in the living being itself. God, the Infinite Being, is a living Being, but His life is free from all the limitations and imperfections of created life, it is supremely immanent activity, and consists in His knowledge and love of His infinite perfection In the three forms of life that we have been considering, vital activity is not perfectly immanent, because it does not have its source and term wholly within the living being At the lowest level of immanence, we have the plant; in the action of absorbing food, it is the source of the action and is perfected by the action, but it is dependent on matter drawn from its surroundings, in reproduction, it preserves its specific nature in existence, but by the formation of an individual distinct from itself Sense-knowledge, the vital activity proper to animals, manifests a higher degree of immanence, for although this knowledge originates through the stimulation of the external sense by some material object, it does not require the absorption of the substance of the object and it terminates in the formation of an image that remains within the animal The brute animal, however, does not know itself as a self it has no true consciousness of self, for this implies intellectual knowledge, the knowledge of oneself as a substantial subject of existence. Consciousness of self, in which vital activity reaches a higher level of immanence than is found in the brute animals, is proper to man The action by which man is conscious of himself as a self proceeds from the intellect and terminates in the intellect, and it has the intellectually acting subject as its object, as that which is known However, this intellectual activity is not perfectly immanent, for in order that the intellect may know itself, it must first know some object other than itself, and for this prior knowledge it depends to a certain extent on the senses and on the material object that stimulates the senses Perfect immanence is found only in the vital activity of God, which is one with Himself and consists in

an everlasting self-contemplation He is, in the words of Aristotle, "a Thinking of Thought itself," or in the language of St Thomas, "Subsistent Intellection," comprehending in one eternal act, which is Himself, the infinite perfection of His Being [17]

[17] Cf St Thomas, Contra Gentes, Bk IV, ch 11

PART III

THE ORIGIN OF DIVERSITY IN THE PLANT AND ANIMAL KINGDOMS

THE ORIGIN OF DIVERSITY IN THE PLANT AND ANIMAL KINGDOMS

WE have seen that we are compelled by the principle of causality to admit a special exercise of Divine causation to account for the origin of each of the three forms of life The question we have now to answer is this Did God bring into existence from inanimate matter a single form of plant life and a single form of animal life, so that the plant and animal kingdoms, now so highly diversified, are each descended from a single ancestor? Or did this Divine action directly produce a considerable number of different forms in each kingdom? In other words, are the one million and a half species of plants and animals now in existence[1] descended from two primordial forms, or, as L S Berg maintains, from tens of thousands, or from one million and a half?

Some have held that the problem is to be solved on *a priori* grounds Thus Professor D M S Watson writes "Evolution itself is accepted by zoologists, not because it has been observed to occur or can be proved by logically coherent evidence to be true, but because the only alternative, special creation, is clearly incredible"[2] Similarly, Canon Dorlodot declares that "the application of certain principles of Catholic philosophy and theology to the data of the sciences of observation transforms into an absolute and reasoned certitude the conviction of the simple naturalist in favour of a very advanced system of transformism"[3] The principles to which Dorlodot appeals are these the absolute veracity of God, who has allowed all the facts to point in the direction of transformism and so would have deceived us if transformism were not true, the incompatibility

[1]Dobzhansky gives this as a conservative estimate Cf Genetics and the Origin of Species, Columbia U P, New York, 1937, p 1

[2]Rep Brit Assn Adv Sci 1929, pp 88-95 Quoted in Dewar and Davies, Obsessions of Biologists, p 11

[3]Darwinism and Catholic Thought (Tr E C Messenger), Burns Oates, London, 1922, p 97

of special creation with the purpose of the universe, which is to manifest the glory of God, and the impossibility of assigning miracles as the cause of the natural order, as the theory of special creation would require us to do

Such *a priori* solutions of the problem are unacceptable, because it cannot be shown that the special creation of a considerable number of living forms is incompatible with any of the Divine attributes As G B. O'Toole says "To say that God is constrained by His infinite Wisdom to indirect, rather than direct, production, or that He must evolve a variety of forms out of living, rather than non-living, matter, is to be guilty of ridiculous anthropomorphism There is no *a priori* reason, founded upon the Divine attributes, which restricts God's creative action to the production of this, or that, number of primordial organisms, or which obliges Him to endow primitive organisms with the power of transmutation "[4]

On the other hand, it would be difficult to demonstrate by philosophical argument that the evolution of the plant or the animal kingdom each from a single stock is impossible

The question must then be answered in the same way as any other question of fact, that is, *a posteriori,* in accordance with the scientific evidence We have therefore to weigh the scientific evidence and draw our own conclusions, deciding on the evidence whether all the various forms are descended from one or a few stocks in each kingdom or have come into existence independently of one another

Since the evidence to be considered is furnished by the various departments of biology, the discussion of this problem belongs primarily to theoretical biology, but it also falls within the province of natural philosophy, which has to provide a philosophical interpretation of the conclusions of biology If biologists were unanimous in their conclusions regarding the present problem, the philosopher could perhaps content himself with a brief survey of the scientific evidence, but since their opinions differ widely, he has to study the subject carefully for himself and draw his own conclusions As Bergson says "Philosophers cannot today content themselves with vague generalities, but must follow the scientists in experimental detail

[4]The Case against Evolution, p 70

and discuss the results with them"[5] To forestall possible objections, it may be as well to show by a few considerations that a philosopher may be competent to deal with this question of the origin of diversity within each kingdom First, the problem is primarily one of logic, of determining what can be validly inferred from the data available, the data are provided by the scientific specialists—zoologists, embryologists, etc, but the philosopher, because of his special training in logic, is at least the equal of the average biologist in interpreting these data Secondly, the philosopher is less likely to be the unconscious victim of philosophical prejudices in solving the scientific problem, a biologist, on the other hand, may easily propound a philosophical theory without being aware of it, as Julian Huxley does when he tells us that "modern science must rule out special creation or divine guidance" as the cause of adaptation[6] Thirdly, most biologists are experts only in a narrow field, and have no more information regarding all the other departments of biology than is available to the philosopher, and if they hold a theory of evolution, they commonly admit that their acceptance of it is based, not so much on their findings in their own field, as on the evidence provided by all the other departments of biology Finally, for an adequate appreciation of the relevant data, it is not necessary to have an expert knowledge of biology, still less to be trained in the technique of biological research An educated person of ordinary intelligence can understand *The Origin of Species* or a modern text-book of palaeontology

We shall discuss the problem under four heads (1) the question—an account of the various types into which the plant and animal kingdoms are divided, (2) the answers—an account of the various theories regarding the relationship of these types to one another, (3) the facts—an account of the data bearing on the question provided by palaeontology and the other branches of biology, (4) conclusions—what can be logically inferred from these data, and what is to be thought of the different theories

[5]Creative Evolution, p 82
[6]Evolution, the Modern Synthesis, Allen and Unwin, London, 1942, p 457

1

THE QUESTION

It has sometimes been said that in nature there are no classes or orders, only individuals Lamarck, for example, devotes a chapter to showing "how schematic classifications, classes, orders, families, genera and nomenclature are only artificial devices" and that "nothing of the kind is found in nature."[1] A little reflection will show that this conception is false The myriads of living bodies in the world are not all completely different from one another, but fall into a number of well-defined groups, the members of each group resembling one another more than they do the members of any other group The less extensive groups fall into wider groups and these into still wider, until finally we arrive at a complete systematic classification of the plant and animal kingdoms "The subdivisions of the animal and plant kingdoms established by Linnaeus" Th Dobzhansky writes, "are with few exceptions retained in the modern classification, and this despite the enormous number of new forms discovered later These new forms were either included in the Linnaean groups or new groups were created to accommodate them There has been no necessity for a basic change in the classification This fact is taken for granted by most systematists and all too frequently overlooked by the representatives of other biological disciplines Its connotations are worth considering. For the only inference that can be drawn from it is that the classification now adopted is not an arbitrary, but a natural one, reflecting the objective state of things"[2] In this classification the higher categories are founded on basic similarities affecting the whole organism, and so the entire system of categories forms an organized, hierarchical whole, the first subdivisions of the

[1] Zoological Philosophy (Tr H Elliott), Macmillan, London, 1914, pp 19-29

[2] Genetics and the Origin of Species, p 304

kingdom being the most important ones, so far as the theoretical biologist is concerned There are, of course, differences of opinion among biologists about matters of secondary importance, but they all accept the classification in its main lines

The first sub-division of the kingdom is into phyla, the phylum is sub-divided into classes, the classes into orders, the orders into families, the families into genera, and the genera into species These are the main groups, but sometimes, because of the large number of forms comprised within a single group, it is necessary to interpose a sub-division, e g, to group the families of an order into several sub-orders The following is a complete list · phylum, sub-phylum, class, sub-class, order, sub-order, family, tribe, sub-tribe, genus, section, species, the species is sub-divided into sub-species, races, clines, etc

The lowest divisions, such as family, genus, species, are of considerable importance to the systematist, for without them he could not classify the numerous forms belonging to a single type, such as the 12,000 species of the class, Birds, these divisions are of less interest, however, to the morphologist, for the differentiating features on which they are based do not bear on the fundamental organization of the type, however much the birds differ among themselves, they all embody the type Bird, which is fundamentally different from the type Fish

If we take the Dogs as an illustration of classification in the animal kingdom, we have first the various breeds of dogs that constitute the **systematic species**, *Canis familiaris* A systematic species is a group of individuals that resemble one another closely in all their characters and if living together in nature will inter-breed and produce fertile offspring The **genus** Canis, of which *C familiaris* is a species, includes also the Wolf (*Canis lupus*) and the Jackal (*Canis aureus*) The genus Canis and the genus Vulpes (the Foxes) belong to the Dog **family**, the Canidae The Dog family has many points of similarity with such other families as the Bears and Cats—the paws are adapted to the seizing and tearing of prey, the jaws to the eating, and the intestinal tract to the digestion, of flesh All these families are therefore placed in a still wider group, the land Carnivora the **sub-order** Carnivora fissipedia The land Carnivora, in turn, are grouped with the aquatic Carnivora, Carnivora pinnipedia, in the **order** Carnivora The Carnivora belong to a still wider

group, the **sub-class**, Mammalia placentalia, or animals that suckle their young and nourish the embryo within the womb by means of a placenta This sub-class contains most of the other mammals, and includes the following orders, besides the Carnivora Edentata (ant-eaters), Sirenia (manatee, dugong), Cetacea (whales, dolphins), Insectivora (moles, shrews), Rodentia (rats, rabbits, beavers), Ungulata (horses, camels, cows, pigs), Chiroptera (bats), and Primates (lemurs, monkeys, apes) The Placental Mammals, together with two other sub-classes, the Monotremes (platypus, echidna), and the Marsupials (opossum, kangaroo, wombat), constitute the **class** Mammalia, or animals that suckle their young The Mammals are grouped with several other classes (Birds, Reptiles, Amphibians, Fishes) to form the **sub-phylum** Vertebrata, consisting of animals that possess a skeleton of jointed vertebrae The Vertebrata, with several comparatively unimportant sub-phyla, form the **phylum** Chordata, consisting of animals that possess a notochord—the name given to the stiff rod that serves as a backbone in the non-vertebrate forms, and to the embryonic backbone of Vertebrata

THE ANIMAL KINGDOM is commonly divided into the following phyla

1 Protozoa unicellular organisms, such as the amoeba
2-13 Metazoa multicellular organisms, comprising the following phyla
  2. Porifera the sponges
  3. Coelenterata corals, jellyfish
  4 Platyhelminthes flat-worms
  5 Nemathelminthes thread-worms
  6 Trochelminthes wheel-worms, wheel animalcules
  7 Annelida segmented worms, such as earthworms, leeches
  8 Echinodermata sea-urchins, starfish, sea-lilies
  9 Bryozoa or Polyzoa sea-mats
  10 Brachiopoda lamp-shells
  11 Mollusca clams, snails, cuttlefish, octopuses
  12 Arthropoda crayfish, centipedes, spiders, insects
  13 Chordata a Non-vertebrate Chordata · *Amphioxus, Balanoglossus,* Tunicata b Vertebrata fishes, frogs, snakes, birds, mammals

The Plant Kingdom is usually divided into the following principal groups

1 Phanerogams the flowering plants
   a. Angiosperms with the seed enclosed in an ovary
      i Dicotyledons with two seed-leaves (40 Orders roses, oaks, etc.)
      ii Monocotyledons with one seed-leaf (11 Orders lilies, etc)
   b Gymnosperms with the seed not enclosed in an ovary (e g , conifers)

2. Cryptogams spore-producing plants
   a Higher Cryptogams Ferns and Mosses
   b Lower Cryptogams Algae and Fungi

It is reasonable to infer that all the various types of dog now included in the species *Canis familiaris* are descended from a single type, and perhaps from a single pair of ancestors, so that if the family trees of all the individuals that now constitute this species could be traced they would be found to merge in a common stock at the dawn of canine history The question is May we go further than this and affirm that, because of the close structural resemblance of all the members of the family Canidae to one another, they too are all descended from a common ancestral type? Going further still, may we say the same of the whole order of Carnivora, making it the progeny of some primitive undifferentiated carnivore? May we then go on to assert that all the mammalian orders are descended from an undifferentiated mammal? Finally, may we not derive all the multicellular types from some primitive unicellular organism?

In other words, are we to regard the whole animal kingdom as bound together by ties of true genealogical relationship? Or are the groups thus related more limited in extent? And if they are limited, do the limits coincide with those of the systematic species, or the family, or the order? The same questions are raised concerning the plant kingdom

2

THE ANSWERS

THE various hypotheses that have been formulated to account for the present diversity of the plant and animal kingdoms fall into three main classes Fixism, Extreme Evolutionism, and Moderate Evolutionism We shall consider each of these in turn

FIXISM

Fixism, or Permanentism, is the theory that there has been no change of species, so that the ancestors of the species now in existence must always have belonged to the same species as their descendants Those individuals belong to the same species that resemble one another fairly closely in all their characters and when mated produce fertile offspring The crucial test of specific identity is the capacity to produce fertile offspring "The oldest conception of species, and the one which has not yet been replaced," writes R Goldschmidt, "states that the decisive differences between species of animals are sterility of hybrids between species and the more or less complete physiological isolation preventing hybridization"[1] In some cases, e g, in the classification of insects, systematists have treated as distinct species groups that are really sub-specific; such groups, while differing slightly in form, would produce fertile offspring if they were crossed Apart from these cases, however, there are many instances of forms which, although allied, are certainly distinct species, e g, the horse and the donkey According to the Fixist theory, the ancestors of the horse would always have been horses, and the ancestors of the donkey never anything but donkeys, the pedigrees of the two forms would never converge to meet in a common ancestor Still less, of course, would the pedigree of either include such forms as an undifferentiated mammal, a reptile, or a fish.

[1]The Material Basis of Evolution, Yale U P, 1940, p 114

Fixism represents the view of most of the ancients, including St Augustine, and although some of the early Greek philosophers were evolutionists, in Christian times Fixism was hardly questioned until the eighteenth century The classical formulation of Fixism is the dictum of Linnaeus "There are as many different species as the Infinite Being created diverse forms in the beginning" For a time the fossil remains of species now extinct were commonly held to be freak rock formations, but as it became evident that these were really the remains of extinct forms of life, it was held that present-day species represent only some of the species originally created, the others having perished in the Deluge Then it was found that after the destruction of some species, others appeared as fossils for the first time Some held that these new species were immigrants from parts of the earth that had escaped the cataclysm, but eventually this explanation had to be abandoned as too improbable, and it was admitted that besides the species created at the beginning, other species had been created at later periods in the history of the earth D'Orbigny, an eminent palaeontologist, in 1849 put forward the theory that there had been twenty-nine different creations, one world of living things being totally destroyed before the next took its place This theory is difficult to reconcile with the fact that fossils of the same specific form are found in many different epochs Accordingly, later Fixists maintained that many species have survived for long periods and others have become extinct, at intervals, groups of new species, not the descendants of any previously existing species, have come into existence

Among those who have expounded Fixism in recent times is O Kleinschmidt, whose theory of the Formenkreis, according to Mayr, "has been unquestionably one of the most productive working hypotheses of taxonomy"[2] Kleinschmidt holds that the animal world can be grouped into Formenkreise, which are natural or anatomical species, and must "in our present state of knowledge, be regarded as entirely independent formations, which are separated by material (viz , objective) gaps in their origin"[3] It is sometimes difficult, he says, to determine whether

[2]Systematics and the Origin of Species from the Viewpoint of a Zoologist, Columbia U P , New York, 1942, p 112
[3]The Formenkreis Theory and the Progress of the Organic World (Tr F C R Jourdain), Witherby, London, 1930, p 176

two forms constitute a single Formenkreis or two, but he places as distinct Formenkreise forms that seem to be closely related, such as the peregrine falcon and the gyrfalcon, the tree sparrow and the house sparrow, the marsh titmouse and the willow titmouse

Fixism is often called Creationism, but the term is not a good one, because not all Fixists are theists, and those who are do not affirm that specific forms have been created in the strict sense, i e , produced out of nothing If the Fixist is a theist, he will attribute the origin of each species to a Divine action producing the living form out of matter already in existence If, like De Quatrefages, he is an agnostic, he will not attempt to assign a cause for the production of the different species, but will content himself with the assertion that the permanence of species is a well-established scientific fact

Extreme Evolutionism

Extreme Evolutionism is the theory that the different kinds of plants and animals are all descended from a single primordial living form During the millions of years that have elapsed since life began, the descendants of this ancestral type have become increasingly different from it and diversified among themselves Some exponents of the theory derive each kingdom from a separate stock, but most regard both kingdoms as originating from a single ancestor The theory is also known as Monophyletic Evolutionism and Rigid Transformism

Although Empedocles (5th century B.C) taught a kind of evolutionary biology, Buffon (1707-1788) was the first naturalist to propound the theory in its modern form, emphasizing the power of natural forces to change the organism and dwelling on the part played by time in the formation of species However, he did not express any very definite conclusions on the way in which species would have been transformed

About the same time, the investigations of several anatomists revealed a unity of organization in the various forms of animal life, and from this it was only a step to assert the genealogical continuity of living forms.

Etienne Geoffroy St Hilaire (1772-1844) took this step and asserted that in each class of animals the different forms had at the beginning the same organization and that the present variety is due to the development of certain organs in some

and of other organs in others Every mammalian embryo, for example, possesses in itself the germs of every organ found in mammals, but only some of these germs develop in each type of mammal He declared that although only small changes take place now, great changes took place in the past, and he attempted to describe these changes, e g , those by which a vertebrate originated from a cephalopod mollusc such as an octopus He left his contemporaries quite unconvinced

More important than either Buffon or St Hilaire was Lamarck (1744-1829), who put forward a theory of Extreme Evolutionism in lectures in 1800 and in several books, notably his *Zoological Philosophy,* published in 1809 He affirmed that the organic world arose from inorganic matter by spontaneous generation, the animals from gelatinous matter, and the plants from mucous matter The various forms of animal life arose from two sources—the Infusoria, and the Worms The Infusoria, formed by spontaneous generation, gave rise to Polyps, Coelenterates and Echinoderms, the Worms, formed in bodies already organized, gave rise to all the rest—Insects, Fishes, Reptiles, Birds, Mammals

Living things are modified by external factors, such as climate, but chiefly by the use or disuse of their organs, the animal transmits these changes to its offspring by heredity, and eventually, when such changes have accumulated over many generations, we have an organism so different from the original type that it ranks as a separate species

The theory may be summed up under the following heads

1 A change in external conditions causes new wants for the organism, to satisfy these, it must change its manner of life, using some organs more frequently and allowing others to fall into disuse

2 The prolonged use of an organ makes it larger and stronger, while its disuse causes it to atrophy and eventually to disappear altogether

3 Some organs are therefore gradually changed in size and shape, while others disappear; sometimes, new organs arise to meet new needs

4 These changes are handed on by heredity, and, accumulating with each succeeding generation, they result eventually in the appearance of a new specific type

5 We may account in a similar way for the appearance of larger groups, such as orders and classes

In this theory, the evolution of the long neck of the giraffe is explained thus an undifferentiated ruminant, living in the dry parts of Africa, developed a longer neck through its efforts to reach more of the scanty foliage, the length of the neck increasing in the course of many generations Lamarck gives the following explanation of how the webbed foot originated "The bird which is drawn to the water by its need of finding there the prey on which it lives, separates the digits of its feet in trying to strike the water and move about on the surface The skin which unites these digits at their base acquires the habit of being stretched by these continually repeated separations of the digits, thus in course of time there are formed large webs which unite the digits of ducks, geese, etc, as we actually find them In the same way, efforts to swim, that is, to push against the water so as to move about in it, have stretched the membranes between the digits of frogs, sea-tortoises, the otter, beaver, etc"[4]

He drew up a comprehensive genealogical table of the whole animal kingdom which is important as being the first in a field where so many were to follow He held that the Worms divided into two groups, the Insects, Spiders, Crustacea arising from one group, the Annelid Worms, Cirrhipedes, and Molluscs from the other The Molluscs in turn gave rise to two groups of descendants, the Fishes and the Reptiles From the Reptiles there sprang two groups, one comprising the Birds and the Monotreme Mammals, the other Amphibian Mammals similar to the crocodiles From these Amphibian Mammals all the different orders of mammals arose, the different mode of life adopted by each order causing it to develop different organs Some, like the seals, developed the habit of feeding on flesh and came ashore, to form the source of the Carnivores and Rodents, others lived on vegetation, and, coming ashore, passed into the interior of the continents, to become the source of the Ungulates Others again remained in the sea and got into the habit of coming to the surface only to breathe, thus from lack of exercise they lost the use of their rear limbs, while their fore limbs turned into flippers, these last formed the stock from which the order of Cetacea (Whales) is sprung

[4]Zoological Philosophy, p 119

Thus Lamarck assigned a positive cause to account for evolution, viz, the capacity of the living body to adapt itself actively to new conditions In this respect his theory is superior to Darwin's, where the principal part in evolution is played by natural selection, which is merely an eliminating factor, not a positive cause

The great anatomist, Cuvier (1769-1832), attacked the theories of St Hilaire and Lamarck, pointing out how the factors they invoked could account for the production of new varieties, but not the development of one type from another, e g, of birds from reptiles There is no sign that such vast changes have occurred, and, if they had, Lamarck's theory would not explain them As the result of Cuvier's criticism, these evolutionary theories faded into the background as hypotheses which a few regarded with sympathy but no one considered as demonstrated or demonstrable

Charles Darwin (1809-1882), during voyages as a naturalist attached to *H M S Beagle* between 1831 and 1836, had noticed the similarity between the fauna of the Galapagos islands and that of the American continent hundreds of miles away, a similarity that, despite the differences, pointed to a common origin After his return to England, he studied for a long time the geographical distribution of species and the conditions of their migration and dispersion He also collected a great many data on the variations of species and gradually came to the conclusion that species had not the fixity usually attributed to them, and that in many cases there was a gradual transition from one species to another and where gaps existed this was due to the disappearance of the intermediate forms If one could form a complete picture of the history of forms apparently quite distinct, one would perceive that they were descended from a common ancestor

Darwin conceived of nature as simply a vast multitude of individual living things, for the sake of convenience these are divided into groups according to the degree in which they resemble one another, and thus we have such groups as variety, species, genus, etc He writes "From these remarks it will be seen that I look at the term species as one arbitrarily given, for the sake of convenience, to a set of individuals closely resembling each other, and that it does not essentially differ

from the term variety, which is given to less distinct and more fluctuating forms "[5] He paid less attention to the larger groups, such as genus, family, order, class, but regarded them as equally artificial The problem he set himself to solve was Why do living things resemble one another in certain respects and differ in others?

The resemblances are due to the descent of the various forms from a common ancestor. He did not discuss the origin of life beyond attributing it to the action of the Creator He started with living substance already in existence and possessing a few general characteristics that he did not define any further At first he was of the opinion that "animals are descended from at most only four or five progenitors, and plants from an equal or lesser number," but later he thought that "probably all the organic beings which have ever lived on this earth have descended from some one primordial form "

The extent of each group and the number of its subdivisions corresponds to the amount of time that has elapsed since the existence of the initial form from which the whole group is descended The initial form has in the course of time given rise to several branches passably distinct from one another but possessing the essential characteristics of the initial form, i e, the characteristics of the higher group to which these branches belong

The resemblance is then to be explained by community of descent How are the differences to be accounted for? What were the factors that caused the different branches of the higher group to develop and become distinct from one another?

Coming from a region where stud animals were raised, Darwin was struck by the care with which the breeders selected the animals from which they bred He was also acquainted with the works of Malthus, who taught that the rate of increase of the population was higher than the rate at which the production of food could be increased, so that the human race would be threatened with starvation unless there were factors limiting the increase of the population The most effective agency tending to restrict the population of any species is the struggle for existence, to which is due the great difference between the number of offspring produced in a year by certain animals and

[5]The Origin of Species, 6th Edition, Murray, London, 1897, p 39

the number surviving at the end of the year. Malthus also pointed out how the struggle for existence procured the well-being of mankind by eliminating the unfit. It occurred to Darwin that here was the agency he was looking for, the factor that would enable him to explain how different species had originated from a common ancestor.

All organisms, Darwin argued, tend to increase so rapidly in numbers that the entire surface of the earth would not be large enough to hold the progeny of a single pair after a number of generations if all the offspring survived. The food supplies of any species are limited, and hence there ensues a struggle for existence in which the strongest, or rather, those best adapted to the environment, prevail, and the others fail. The reason why some are better adapted than others is that they are more favourably endowed by heredity. It is a well-known fact that children always differ in some respects from their parents and from one another. Sometimes these variations are an advantage, and sometimes a handicap, in the struggle for existence. An offspring may vary from the parent type in an indefinite number of particulars; that it varies in the way it actually does is due to chance. Chance variation is, therefore, the reason why some offspring are better adapted than others to the environment and survive in the struggle for existence. The survivors hand on these advantageous variations to their offspring, in some of whom the advantageous variation is, by chance, increased still further in the same direction. After many generations, the accumulation of variations in a number of characteristics results in the formation of a new species. In this way the struggle for existence develops new species by selecting chance variations, in much the same way as the breeder develops new races; it exercises a "natural selection" and so ensures that the offspring are bred from individuals whose variations make them best fitted to survive.

This process of natural selection, which enables us to understand the diversification of species, accounts also for the formation of all the diversity there is in the plant and animal kingdoms. The types represented now by phyla, classes, orders, and families were formed from the primordial forms of life by chance variation and natural selection. Chance variation and natural selection, therefore, provide us with an adequate explana-

tion of the apparent order and hierarchical arrangement of organic forms that the naturalist discovers in the living world

This is, in outline, the theory put forward in the famous book, published in 1859, *The Origin of Species by Natural Selection, or, The Preservation of Favoured Races in the Struggle for Life* Several currents of thought had prepared the public mind for the acceptance of such a theory and the book was instantly a great success What made the theory attractive to many was the doctrine that the order in organic nature (manifest in such structures as the vertebrate eye), which had been regarded as conclusive proof of the existence of an Intelligent Author of Nature, could now be explained as the product of chance variations chosen by the blind action of natural selection Thus E du Bois-Reymond declared that Darwin's "greatest title to glory" was to have shown the possibility of banishing from nature its seeming purpose, and putting a blind necessity everywhere in the place of final causes[6] Strakhov also remarked on this feature of Darwin's theory "The strength of Darwin's theory," he wrote, "its intellectual attractiveness, emphatically consists in the supposition that laws do not exist and that phenomena may be reduced to the play of chance"[7] The evidences of design used by Paley to demonstrate the existence of God could now be attributed to Natural Selection Furthermore, not only was the theory intellectually attractive to many on philosophical grounds, the vast array of scientific facts Darwin quoted in support of it seemed to give it a solid basis in natural science

In 1871 Darwin published *The Descent of Man,* in which he asserted that man has evolved, soul and body, from one of the Old World apes through the action of natural selection on chance variations This book was complementary to *The Origin of Species,* in which nothing had been said of human origins It contains a genealogical table, tracing the ancestry of man back to a unicellular organism, the list of ancestors is similar to Haeckel's, the main difference being that Darwin is tentative, where Haeckel is assertive

[6]Darwin versus Galiani, "Reden," Vol I, p 211 Quoted in O'Toole, The Case against Evolution, p 11

[7]Quoted in L S Berg, Nomogenesis (Tr. J N Rostovstow), Constable, London, 1926, p 150

As time went on, Darwin attributed increasing importance to Lamarckian factors, holding that variation is due not merely to the chance effects of heredity but also to the action of the environment on the organism "I hardly know why I am a little sorry," he wrote to Hooker, "but my present work is leading me to believe rather more in the direct effect of physical conditions I presume I regret it because it lessens the glory of Natural Selection and is so confoundedly doubtful"[8] It seems he was inclined to make an idol of Natural Selection

Darwin's theory was rejected by many eminent scientists, especially because of the dominant role it assigned to chance, but not much attention was paid to their criticism, and until the nineties the great majority of biologists, especially in English-speaking countries, were Darwinians, and the general public naturally followed the lead of the biologists

In the eighties and nineties, however, Herbert Spencer and other neo-Lamarckians pointed out that the theory of evolution by natural selection is not in accord with the facts, because observation shows that natural selection plays only a minor part in the development of new forms of life The neo-Darwinians, led by Weismann, replied by denying the cardinal doctrine of Lamarckism, the inheritance of acquired characteristics This controversy marked the beginning of a crisis in evolutionary thought, a crisis that still endures

Further blows to the theory of Darwin were dealt by such men as A Fleischmann, H Driesch, and W Bateson, and by 1910 it had been largely abandoned on the higher levels of scientific thought However, developments in the field of genetics in the twenties and thirties led to the revival of some of Darwin's ideas, and a number of modern biologists claim to be Darwinians, although their views often differ widely from those of Darwin Some of them, for example, admit that the origin of species does not throw much light on the origin of the higher divisions of the organic world This not very coherent neo-Darwinism is expounded by Julian Huxley, J B S Haldane, J Needham, C Waddington, R A Fisher, M J D White, and others in England, and by Th Dobzhansky, E Mayr and others in America According to Mayr, the Darwinian theory of evolution

[8]Life and Letters of Charles Darwin, Murray, London, 1888, Vol II, p 390

by natural selection is still the orthodox view in biological circles in America.

At the beginning of the present century, De Vries put forward a theory of evolution known as Mutationism. According to this theory the transition from one species to another would not have occurred gradually, as Lamarck and Darwin held, but by sudden large changes, which happened seldom and irregularly. A similar theory had been proposed earlier by Kolliker, who called these changes "saltatory variations," and by Korschinsky, who used the term "heterogeneous variations." What made De Vries's work important was that he seemed to have found some evidence for the theory in the results of breeding from *Oenothera lamarckiana,* the evening primrose. De Vries held that this form gives rise to some offspring that are sufficiently different from the parent type to be classified as new species and breed true. Even if the parent plant were a pure strain and the results as De Vries described, Extreme Evolutionism would still be a long way from being proved, for the two types of *Oenothera*—parent and offspring—despite their "specific" difference, remain the same in their essential structure and mode of life. It is now admitted by everyone, however, that *Oenothera lamarckiana* is not a pure strain, but a peculiar kind of hybrid, this means that the difference in the offspring is not due to a true mutation, but to a complex recombination of characters that were present in the parent type. Moreover, the phenomenon is rare, and cannot provide a satisfactory starting-point for a general theory of evolution.

Mutationism has this advantage over Lamarckism and Darwinism, that it does not have to postulate so many transitional forms of which there is no trace in the fossil record. A recent exponent of Mutationism, Goldschmidt, accepts the verdict of the palaeontologist, Schindewolf, that "the many missing links in the palaeontological record are sought for in vain because they have never existed," and quotes with approval his statement that "the first bird hatched from a reptilian egg."[9] Such a theory is, however, confronted with the difficulty of discovering natural causes sufficient to produce such an immense transformation in a single step.

[9]The Material Basis of Evolution, p. 396

Extreme Evolutionism in one form or another is still the view ostensibly accepted by the majority of biologists The usual line they take is to affirm that, although there is no satisfactory account of the causes of evolution, the fact of evolution is beyond doubt "With all biologists," writes Goldschmidt, "we assume that evolution as such is a fact"[10] Dobzhansky says "Among the present generation no informed person entertains any doubt of the validity of the evolution theory in the sense that evolution has occurred, and yet nobody is audacious enough to believe himself in possession of the knowledge of the actual mechanism of evolution"[11] G Salet and L Lafont, after noting the doubts expressed by certain eminent scientists about Extreme Evolutionism, go on to say "Nevertheless, Transformism continues to be taught officially, as a fact of experience, or at least as the only possible theory Hundreds of thousands of schoolboys and students have in their hands works in which this theory is expounded as quite certain Thousands of people have at their disposal dictionaries and encyclopaedias in which transformist ideas alone get a hearing The works published by the scientific collections (Doin, Payot, Alcan, Albin, Michel, etc) are almost exclusively transformist The service maintained by the Paris Museum of Natural History for the sale and hire of scientific works makes available books that, with a few rare exceptions, expound Mechanistic Transformism One may affirm in all objectivity that French scientific teaching at the present time is completely transformist"[12]

MODERATE EVOLUTIONISM

Moderate Evolutionism is the theory that, although there has been considerable modification of organic types since life first appeared on earth, evolution has not been so extensive as Extreme Evolutionism contends The plant and animal kingdoms are not each descended from a single primitive form, but from a large number of such forms, which came into existence separately Consequently, if one wished to represent the development of the living world in diagrammatic form, the diagram would not be a single tree, of which all the various groups would

[10]The Material Basis of Evolution, p 4
[11]Genetics and the Origin of Species, p 1
[12]L'Évolution Régressive, Éditions Franciscaines, Paris, 1943, pp 20-21

be branches, but a considerable number of separate shrubs, growing independently of one another.

Some exponents of Extreme Evolutionism, e g , A M. Davies, are unwilling to admit that Moderate Evolutionism is an evolutionary theory at all, but their attitude is unreasonable, because Moderate Evolutionism admits that a good deal of evolution has probably taken place and rejects Fixism as improbable According to this theory, which is also called Mitigated Transformism, or Polyphyletic Evolutionism, certain types seem to have undergone such changes in the course of ages that the descendants would be classified by the morphologist as specifically different from their ancestors and would probably not interbreed with these ancestors if both forms were alive at the same time The theory does not attempt to determine the exact number of primordial forms, merely pointing out that estimates should be based on the data of palaeontology and morphology, and that, in accordance with the principle of economy, the number should be kept as low as the facts seem to demand

Father E Wasmann, in his *Modern Biology and the Theory of Evolution,* declared that Moderate Evolutionism is the only hypothesis that is scientifically probable "Among modern zoologists and botanists, and still more among palaeontologists," he wrote, "the number is ever increasing of those who think that the evolution of both animals and plants was polyphyletic, and who regard the monophyletic hypothesis as merely a pretty fancy on the part of supporters of the theory of descent in its crude form—a fancy that they cannot hope to prove true, for comparative morphology and ontogeny of living organisms, as well as the discoveries made by palaeontology, all alike render it more and more improbable that anyone will ever succeed in establishing a monophyletic evolution of either the animal or the vegetable kingdom on a scientific basis It becomes more and more probable that a monophyletic evolution does not correspond with the facts No serious student is at present able to tell us with certainty how many independent lines of descent, or series of evolution, we must assume to exist among animals and plants respectively This is due partly to the fact that the answer to this question depends greatly upon the subjective ideas of each individual, but the chief reason for it lies in the

significant circumstance that a final answer will be possible only when we have a perfect knowledge of both the present and the fossil organic world."[13] To the group constituted by all the individuals belonging to one independent line of descent Wasmann gave the name "natural species" Thus he regarded as one natural species "all the varieties of beetle of the Paussidae family, from the Tertiary period to the present time," adding that the natural species is probably wider still

L S Berg, an ichthyologist of the State University of Leningrad, in his book, *Nomogenesis, or Evolution determined by Law,* published in 1922, put forward a theory of Moderate Evolutionism and a devastating scientific criticism of Darwinism "In the present state of science," he wrote, "we may say that both Linnaeus and Darwin were in error, but Linnaeus (who affirmed the special creation of 10,000 species of animals and plants), from the purely quantitative side, was nearer the truth To support the view that animals are descended from four or five progenitors is now impossible the number of primal ancestors must be computed in thousands or tens of thousands

Our point of view is intermediate between that of monophyletic origin, to which Darwin inclined, and that of absolute polyphyletic origin, which was advocated by Linnaeus"[14]

L Vialleton, Professor of Anatomy in the University of Montpellier, published a number of books in which he refuted the classical theories of Extreme Evolutionism and put forward a theory of Moderate Evolutionism His best-known work is *L'Origine des Etres Vivants L'Illusion Transformiste,* which appeared in 1929 and ran through fifteen editions by 1930

He pointed out that the various categories into which the systematist divides the plant and animal kingdoms fall into two groups, the categories in one group being based on one kind of criterion, whereas the categories in the other group are based on an essentially different kind of criterion In the first group which includes all the sub-divisions from the phylum to the order, the criterion is the fundamental structure or organization of the body, and so Vialleton called these categories "types of organization' In the second group, which consists of the subdivisions of the order, the criterion is the form The form, he

[13] Op cit, p 293
[14] Nomogenesis, p 358

wrote, "consists in the special determinations of beings which possess a given systematic organization, determinations realized by the different proportions, the number, and the other details of the parts of this systematic organization"[15] He called the categories in this second group "formal types", these are the families, each of which is subdivided into genera and species

The "types of organization" are fundamentally different, being completely distinct from one another by reason of their basic structure, thus, the vertebrate and the arthropod, the worm and the mollusc, are different "types of organization", the same is true within the vertebrate phylum, of the bird and the fish, the mammal and the reptile, and, within the class of mammals, of the orders, such as the Cetacea (whales), Chiroptera (bats), and Rodentia (rodents)

Within each order, however, the basis of division changes; there is no longer question of diversity of organization, for this remains essentially the same in all the sub-divisions of the order Thus the order of Carnivora is divided into such families as the Ursidae (bears), Canidae (dogs), and Felidae (cats), which have the same organization—that of a carnivorous mammal, but differ in their form—in the shape, size, and proportion of their parts The families are "formal types," and although they are clearly marked off from one another, their differentiating characteristics have not the same significance as those that differentiate the order of Carnivora from other orders, such as the Cetacea or the Chiroptera

Because the "types of organization" differ fundamentally in their structure, it is impossible that one should have evolved gradually from another or that two or more of them should have evolved gradually from a common ancestor, moreover, this deduction from the structural differences is borne out by the facts of palaeontology, which show that all these types came into existence suddenly and have no visible connection with one another or with any parent stock

Gradual evolution of the kind described by Lamarck and Darwin is possible only within the limits of the "formal type," the natural family "Living forms," Vialleton declared, "that is, the natural families, or eventually the sub-orders, are the

[15] L'Origine des Etres Vivants, p 48

formal representatives of different types of organization, and they are capable of living and acting in a certain manner from the moment they first appear They have come into existence independently of one another, by a mutation of such breadth, and so perfectly appropriated to its new task, as to correspond to a veritable creation Their secondary forms—genera and species—are special adaptations, accidental modifications, which cause no fundamental change in the proper or specific idea which the initial form embodies "[16]

He compared the evolution of the vertebrates to the explosions of a rocket Each new explosion of the rocket is not from the sparks already formed, but from a part not yet exploded In the course of history, the organic world has undergone a series of profound changes, but the new forms of life that appear at intervals are not derived from forms already in existence, there seem to be germs latent which suddenly burst into whole groups of new forms of life The evolution that has taken place is therefore quite different from that depicted by the classical theories of Extreme Evolutionism The great types are discontinuous, and this discontinuity is in no way lessened by the continuity of species and genera within such "formal types" as the Horse or the Cat family

"How," he asked, "has this evolution taken place? We have seen that it is neither regular nor continuous, that the present groups are not the younger offshoots of more ancient families Must we imagine that there has been at different epochs the creation in their entirety of new forms? We do not know Would it be preferable to say that the creation of living forms took place at a single instant, the sources of all the forms having appeared together under aspects unknown to us, and having become differentiated afterwards? It is impossible to say What is quite certain is that this differentiation did not take place in accordance with the ideas of classical Transformism, and that all this development, instead of being the result of blind forces, or of chance, bears witness on the contrary to an intelligent activity using existing things in the most rational way to construct the world according to a small number of initial plans "[17]

[16] L'Origine des Etres Vivants, p 345
[17] Ibid, p 378

Since Vialleton had few equals as an anatomist, his criticism of Extreme Evolutionism could not be dismissed as the product of unscientific ignorance. His books were widely read, especially in France, and they had the effect of making French scientific opinion acutely conscious of the weak points of the various monophyletic theories

P. Lemoine, a former president of the Geological Society of France, and director of the Paris Museum of Natural History, has pointed out that, although the majority of scientists still describe themselves as evolutionists, many of them have in their particular department of biology drawn conclusions that are incompatible with the evolutionary theory (i e., classical Transformism). Writing as editor-in-chief of the two volumes of *L'Encyclopédie Francaise* that deal with biology and include contributions from the leading French biologists, he says. "At the present time, all naturalists and all biologists, whatever be their political or religious views, declare themselves convinced evolutionists In recent years considerable efforts have been made, in every country in the world, to discover the different causes of evolution It behoves us then first of all to ask the best qualified among the scientists who have done this work to tell us their views and what experiments they have done What they have to say will be read with interest in the first part of this volume, which is the work of our collaborators Cuénot, Guyénot, Grasse and Jeannel But speaking as a geologist, who views the battle from above, and sees things in the immense perspective of geological time, I must admit that I did not finish reading their contributions without a certain feeling of disillusionment I shall put the matter in a nutshell, and send the reader to the conclusion of this volume for a fuller expression of my views There he will see how, in my opinion, this volume of *L'Encyclopédie,* which I thought would assure the triumph of the evolutionist theories, today on the contrary seems to me to sound their death-knell "[18]

In the conclusion referred to, Lemoine gives a summary account of the facts that make it necessary to reject Extreme Evolutionism "This volume of *L'Encyclopédie Francaise,*" he writes, "will certainly mark an important date in the history

[18] L'Encyclopédie Francaise, Vol V, Les Etres Vivants, Paris, 1937, 5 06–4

of our ideas on evolution, to read it is to realize that this theory seems on the eve of being abandoned. The evolutionary theories with which we were lulled to sleep in our young student days constitute at the present time a dogma that everyone continues to teach, but each specialist in his own department, whether he be zoologist or botanist, is aware that none of the explanations put forward by the evolutionists can stand, whether it be question of Lamarckians or Darwinians or the later schools that have claimed to derive their inspiration from Lamarck or Darwin. Natural selection does not work. Indeed, it has been shown by recent experiments that nature, by a series of mechanisms, achieves the constancy of specific characters. Guyénot writes: 'Natural selection, contrary to the opinion of Darwin, has a conservative effect, and limits the variability of species. . . .' Cuénot adds: 'Each great animal or plant group appeared, became diversified and stabilized at its appointed time, independently of the others. Many types have not undergone any appreciable change—that is, in their general structure, not in the details by which one species is distinguished from another—since remote geological epochs. . . .' Caullery declares: 'The facts registered by genetics do not seem to pass beyond the limits of the species, or at most, the genus. One finds in them no trace of the characteristics by which the differentiation of the more extensive groups—family, order, class—must have been manifested. . . .' It would be impossible to state more clearly that the data of genetics provide no argument in favour of the notion of evolution, but rather tell heavily against it. It used to be constantly said: 'The data of palaeontology alone convince us of the reality of evolution.' The data of palaeontology, however, demonstrate on the contrary that there has been no evolution, or at least, there has been no evolution of the great groups. Palaeontologists are struck especially by two series of facts: the sudden appearance of the groups, and the immense length of time during which certain lines have remained unchanged. . . . Contemporary geologists are all struck by the sudden appearance of new plant and animal forms, and their opinion is the more valuable, because they were brought up on evolutionist doctrines and still call themselves evolutionists, so that they certainly do not voice their views without mature consideration. . . . Carpentier, the palaeobotanist, writes: 'The

principal characteristic of the evolution of the plant kingdom is not so much progressive development as the persistence of types and the apparently sudden appearance of new types .' There is not sufficient time for evolution to have taken place, if indeed it took place at all The rate of evolutionary change has been almost nil during the 400 millions of years whose history is known to us, and so it would be necessary to affirm that the whole evolutionary process took place in the preceding 1000 million years It is, to say the least, a bold hypothesis From all that has been said above, it is clear that the theory of evolution is impossible In reality, despite appearances, no one believes in it any more, and the term 'evolution' is used to signify nothing more than development the terms 'more evolved,' 'less evolved' are used in the sense of 'more perfect,' 'less perfect,' because this is the conventional terminology, admitted and almost obligatory in the scientific world Evolution is a kind of dogma in which the priests no longer believe, but which they uphold for the sake of their people We must have the courage to admit this, so that the men of the next generation may give a different orientation to their research."[19]

Since we are concerned here with settling a question of fact, viz., the number of primordial forms from which the plant and animal kingdoms are descended, we have considered the various theories primarily in terms of the answer they give to this question of fact, and any mention of the causes they assign has been incidental We have divided the various theories into three classes Fixism, Extreme or Monophyletic Evolutionism, and Moderate or Polyphyletic Evolutionism, and in our present context, this division is quite adequate, for every theory will either affirm the fixity of species (Fixism) or deny it (Evolutionism), and if it denies the fixity of species, it will derive the organic world from one or a few types (Extreme Evolutionism) or from a considerable number (Moderate Evolutionism)

[19]L'Encyclopédie Francaise, 5 82 3-8

3

THE FACTS

If we are to make a just appraisal of the theories we have been considering, we must bear in mind that the question which concerns us and which they attempt to answer is primarily a question of fact The question is From how many distinct primordial forms have the plant and animal kingdoms in fact originated? A question of fact, in scientific no less than in legal disputes, is decided on the evidence. In this case, it is clear, the evidence will be provided by the various departments of biology, and it is equally clear that the crucial evidence will be provided by that department of biology which deals with the forms of life that existed in past ages, the science of palaeontology

We must, of course, take account of the findings of such sciences as genetics, embryology and anatomy, but if the conclusions we draw from the data of these sciences are contradicted by the data of palaeontology, these conclusions will have to be abandoned. For example, the Fixist argument, that two groups that will not give fertile offspring when crossed have always been distinct, is not without its force, but if it can be clearly shown from the data of palaeontology that these groups, e g, the horse and the ass, have arisen by gradual divergence from a common ancestor, the Fixist argument will thereby be proved invalid Or again, if the fossil record demonstrates that the birds have evolved gradually from the reptiles, anatomical arguments brought forward to show that such a transformation is impossible will have to be rejected On the other hand, if palaeontology reveals that the organic world always contained the same forms as it does now, this fact will suffice to refute all forms of Evolutionism

We shall therefore divide into two parts the facts that have to be considered, dealing first and at some length with the facts of palaeontology, and afterwards with the facts derived from

the other biological sciences. "Primary and direct evidence in favour of evolution," wrote T. H Huxley, "can be furnished only by palaeontology. The geological record, so soon as it approaches completeness, must, when properly questioned, yield either an affirmative or a negative answer, if evolution has taken place, there will be its mark left; if it has not taken place, there will lie its refutation "[1]

THE FACTS OF PALAEONTOLOGY

i The Succession of the Strata
ii. The Earliest Fossils
iii The Subsequent Succession of Organic Life
iv Palaeontological Evidence of Gradual Evolution
v The Incompleteness of the Geological Record

THE SUCCESSION OF THE STRATA

Geological investigation of the crust of the earth has shown that many of the rocks forming this crust are stratified, i e., they are arranged in layers of varying depth and composition From what we know of the action of such natural agents as rivers and the sea, it is reasonable to conclude that these layers or strata were formed successively in the course of ages, so that, as a general rule, the lowest are the oldest and those nearest the surface the most recent

The strata are the repository of vast numbers of fossils—the remains of organisms, their skeletons or shells, or moulds of these, footprints, etc, the earliest strata in which fossils indisputably appear being the Cambrian The deposition of the strata occupied millions of years and present-day geologists place the beginning of the Cambrian period some 500 million years ago

Since the fossils found in any stratum will, as a general rule, be the remains of plants and animals that lived on earth when that stratum was being deposited, we know, by examining the fossils found in successive strata, what the plant and animal kingdoms were like at successive epochs in the history of the earth It is obvious that the knowledge thus acquired of the ancient faunas and floras will be incomplete Some organisms have no hard parts and so may easily disappear without leaving a trace, in species possessing hard parts the majority of

[1]Address on the Coming of Age of "The Origin of Species," in Darwiniana, Macmillan, London, 1907, p 239

individuals will escape fossilization, and, finally, only a small part of the earth's crust has been examined A great deal, however, has been discovered, and the systematic account of this material constitutes the science of palaeontology

The following are the principal sub-divisions of geological time.

1 Cainozoic Era

Epochs	*Periods*	
i. Quaternary	a Recent	
	b Pleistocene	(began 1 million years ago)
ii Tertiary	a. Pliocene	(„ 15 „ „ „)
	b Miocene	(„ 35 „ „ „)
	c Oligocene	(„ 50 „ „ „)
	d Eocene	(„ 70 „ „ „)

2 Mesozoic Era

i Cretaceous	(„ 120 „ „ „)
ii Jurassic	(„ 150 „ „ „)
iii Triassic	(„ 190 „ „ „)

3 Palaeozoic Era

i Permian	(„ 220 „ „ „)
ii Carboniferous	(„ 280 „ „ „)
a Pennsylvanian	
b Mississippian	
iii Devonian	(„ 320 „ „ „)
iv Silurian	(„ 350 „ „ „)
v Ordovician	(„ 400 „ „ „)
vi Cambrian	(„ 500 „ „ „)

The era represented by the Pre-Cambrian strata is given various names, of which the most correct, as we shall see, is Azoic, since the earth was then devoid of life

THE EARLIEST FOSSILS

No fossils have been found in the Pre-Cambrian rocks, the earliest fossiliferous strata being the Cambrian, which contain the remains of a rich and varied fauna

The theories of Extreme Evolutionism would lead one to expect to find that the earliest forms of life were simple and undifferentiated This expectation is not realized, for the fossil record shows that the first organisms formed a complexus of fully developed and completely differentiated types Most of the phyla of the animal kingdom are represented "It is evident," writes Professor P E Raymond, of Harvard, "that the oldest Cambrian fauna is diversified and not so simple perhaps as the evolutionist would hope to find it Instead of being composed chiefly of protozoans, it contains no representatives of that phylum, but members of seven higher groups [phyla] are present, a fact which shows that the greater part of the major differentiation of animals had already taken place in those ancient times The other phyla not represented are flat-worms, wheel-worms and round worms, Bryozoa, and Chordata, the last the one which contains the most specialized of all animals [the vertebrates] It is also apparent that the animals living in Cambrian times were not strikingly peculiar, since most of them can be assigned readily to phyla erected on the basis of modern ones "[2]

Secondly, the various phyla are not represented by undifferentiated forms, but by individuals that belong to definite sub-divisions of the phylum concerned For example, the phylum, Arthropoda, which includes the classes Crustacea, Arachnida, Myriopoda, Insecta, is represented, not by an undifferentiated arthropod embodying the features common to all four classes, but by members of the class Crustacea, and this class is represented by three sub-classes—Trilobites, Ostracoda, and Malacostraca The Trilobites consist of two orders, which by the end of the Cambrian period included over one hundred genera and one thousand species From the Cambrian, therefore, the living world has consisted of many different forms

[2]Prehistoric Life, p 23

of life, organized according to a well-ordered, hierarchical system. The diversity of organic life and its division into clearly-defined groups is a characteristic of life as soon as evidences of it appear in the strata, and there is no evidence that this diversity is the result of a process of gradual evolution.

It is to be noted, thirdly, that although the forms of life that constitute the Cambrian fauna are simpler than some of those which appear in more recent strata, e g, the vertebrates, they are nevertheless much more complex than the "simple cell" which the theories of Extreme Evolutionism regard as the initial form of life The Trilobites, for example, belong to the same class as the crayfish, and like them have a segmented body, compound eyes, and jointed legs, their structure, in a word, is much more elaborate than we should find in any primordial organism, if Extreme Evolutionism were true The Trilobites, according to Professors W H Twenhofel and R R Shrock, of Wisconsin, "appear as highly developed forms in the earliest Cambrian."[3]

To explain the appearance of the living world in Cambrian times, the exponents of Extreme Evolutionism assume that the Cambrian forms are descended from a long line of ancestors that lived in Pre-Cambrian times Thus Sir A C Seward, an eminent palaeobotanist, wrote "Faith in the fundamental principles of evolution necessitates the assumption that the Cambrian species were derived from Pre-Cambrian ancestors ante-dating by many millions of years their Palaeozoic descendants"[4] That the existence of these Pre-Cambrian ancestors is an assumption and not a scientifically established fact is clear from what Seward says elsewhere about the sharp line of demarcation that marks off Cambrian from Pre-Cambrian strata "The boundary between Pre-Cambrian and Cambrian finds expression in the striking contrast between the almost complete barrenness of Pre-Cambrian rocks and the wealth of marine animals entombed in Cambrian sediments"[5]

Professor D M S Watson makes the same assumption and offers an explanation for the absence of fossils from the Pre-Cambrian "The occurrence of so many phyla, already sharply

[3]Invertebrate Paleontology, McGraw-Hill, New York, 1935, p 413
[4]Plant Life through the Ages, Cambridge U P, 1931, p 99
[5]Ibid, p 93

separated from one another, and with their characteristic and typical structures fully developed, implies that the animal kingdom had a long history in pre-Cambrian times, and the rarity of the pre-Cambrian fossils can only be explained by the fact that the early members of all phyla were unprovided with hard parts capable of ready preservation as fossils. That this explanation is justified is indicated by the fact that, taken as a whole, the Cambrian animals themselves had delicate skeletons primarily of chitin, calcareous shells being rare and when found thin, compared with the corresponding structures of Ordovician and later fossils."[6] The absence of hard parts in the early members of all phyla, which Watson declares to be a "fact," is simply an assumption, but it is a fact that the Trilobites had hard parts and that no earlier members of the phylum are known

Palaeontologists who accept Extreme Evolutionism constantly assume the existence of life in Pre-Cambrian times in drawing up the genealogical tables of the various phyla For example, in the *Invertebrate Paleontology* of Twenhofel and Shrock, we find the following statements "Sponges appear to have originated in the Pre-Cambrian from an ancestral stock similar to the Choanaflagellata.[7] Worms appeared some time in the Pre-Cambrian if the trails and burrows attributed to them are correctly identified Confirmatory evidence for such an early origin is found in the remarkable assemblage of fossils preserved in the Middle Cambrian Burgess shale This fauna contains 11 genera of worms belonging to widely separated families and clearly indicates that a long developmental period must have preceded the time of burial[8] . Ontogenies of species worked out indicate that some Pre-Cambrian annelid worm was very likely the ancestor of the phylum Echinoderma[9]

By most zoologists the echinoderms are postulated to have descended from some wormlike ancestor, which may in turn have been evolved from a simple bilaterally symmetrical animal The hypothetical ancestor is supposed to have given rise to the various types of echinoderms late in the Pre-Cambrian or early in the Cambrian, for the first true echinoderms appear in the latter period This hypothetical ancestral form, which has been

[6]Article "Palaeontology" in Encyclopaedia Britannica, 14th Edition
[7]Invertebrate Paleontology, p 69
[8]Ibid, p 146
[9]Ibid, p 155

named *Dipleurula,* has never been found, but certain very early and primitive cystoids bear close resemblance to it[10] . Brachiopods appear with the earliest animals of the Lower Cambrian and are found fossilized in the marine strata of all subsequent geologic ages to the present The phylum unquestionably originated in the Pre-Cambrian and at the beginning of the Lower Cambrian deployed very rapidly into the various marine environments of the time[11] Because of the presence in the ontogeny of the trochophore stage, the Mollusca are thought to have developed from some wormlike ancestor during the Pre-Cambrian[12] Developing from some aquatic annelid ancestor in the Pre-Cambrian, and apparently existing for a long time in the soft condition still shown by larvae, the Arthropoda were in an advanced stage of evolution by the beginning of the Paleozoic (i e, Lower Cambrian)[13] The Arachnida represent a distinct line of evolution which began almost certainly during the Pre-Cambrian in some primitive crustacean stock[14] The Arthropoda are now generally believed to have evolved during the late Pre-Cambrian from some group of primitive, aquatic annelid worms The beginning of the Cambrian saw them at a high level of development, with a long history behind them, about which nothing is known except by inference At the earliest known periods of their history it is clear that they had already spread through a wide range of environmental conditions, and numerous divisions of the phylum appear to have originated at about the same time The remote ancestors must certainly be sought in Pre-Cambrian strata, and it remains to be shown whether the phylum as now defined had its origin in a single stock or in several closely related ones"[15]

From these statements it is clear that any theory that traces the invertebrate phyla to a single stock is committed to a number of hypotheses regarding the development of life during Pre-Cambrian time In order to assess at their true worth these hypotheses regarding the descent of various Cambrian phyla

[10]Invertebrate Paleontology, p 215
[11]Ibid, p 251
[12]Ibid, p 303
[13]Ibid, p 409
[14]Ibid, p 460
[15]Ibid, p 471-473

from Pre-Cambrian ancestors, we must examine more closely the evidence for the existence of life in Pre-Cambrian time.

There has been an intensive search for fossils in the Pre-Cambrian strata, but the results have been disappointing As Raymond says "Pre-Cambrian times were the real 'dark ages' Many industrious and brilliant geologists have devoted their lives to the study of the rocks then formed, but though they have learned a great deal about them, they have been unable to establish a satisfactory chronology Authentic history begins with the oldest really fossiliferous strata" (i e., the Lower Cambrian).[16]

In the Cambrian strata, fossils are abundant—from one block of Cambrian shale, forty feet long, six feet wide, and seven feet high, Walcott obtained fossils belonging to fifty-six different genera In Pre-Cambrian there are no indubitable fossils, only a few fragments whose organic character has been affirmed by a few scientists, but is generally denied

Walcott is one of the principal champions of the fossil character of certain Pre-Cambrian remains, which he identifies as belonging to calcareous algae, bacteria, sponges, annelids, and arthropods

With regard to the pebbles supposed to have been formed by calcareous algae, Seward writes "My own view is that the occurrence of oolitic grains or larger pebbles built up in successive layers of the Pre-Cambrian does not necessarily afford evidence of plant agency, algae no doubt often had a share in the formation of calcareous pebbles, but it would be going too far to say that their presence is essential."[17] Raymond also expresses doubts about the organic origin of these pebbles and remarks that Professor Holtedahl of Oslo has pointed out that similar concretions are found in situations that preclude the possibility of their having been formed by organisms

Raymond is rather caustic on the subject of Pre-Cambrian fossil bacteria Walcott, he says, "leaves it to be accepted on faith that an organism resembling *Micrococcus,* without hard parts, and less than 001 millimeter in diameter, would be preserved in identifiable condition from Pre-Cambrian time to the present"[18]

[16]Prehistoric Life, p 39
[17]Plant Life through the Ages, p 83
[18]Prehistoric Life, p 30

Walcott reported that he had found real sponge spicules in the Chuar formation of the Grand Canyon, but he did not submit a description or photograph of them to the judgment of other palaeontologists

Atikokania lawsoni, from the Huronian, one of the subdivisions of the Pre-Cambrian, is supposed to be a "spongoid" If it really is a siliceous sponge, say Twenhofel and Shrock, "it represents the only fossil animal known from the first great time division"—the Pre-Cambrian [19] Holtedahl and Abbott, however, have shown that similar structures are of inorganic origin, resulting from the replacement of limestone by dolomite

Atikokania irregularis is thought by some to be another Pre-Cambrian "spongoid" According to Raymond, it consists of aggregates of quartz crystals embedded in a matrix of limestone and is therefore of purely inorganic origin

The annelid fossils consist of burrows that are supposed to have been made by worms It seems clear that such cavities could easily have been produced by inorganic causes

The arthropod fossil consists of some fragments believed to belong to an arthropod allied to the fossil forms, *Pterygotus* or *Eurypterus*, Walcott has given it the name *Beltina danai* Raymond comments "The supposed test is extremely thin and in most cases without any definite outline A few fragments, selected from thousands, do remotely resemble parts of eurypterids This may be said of four of the specimens figured by Walcott Not only is the absence of outline an objection to the reference of these specimens to arthropods, but an even more significant circumstance is their total lack of surface markings This excludes them completely from the Eurypterida, for even small pieces of the tests of these animals show a characteristic series of scales"[20] He adds, however, that the fragments are probably of organic origin, and are perhaps the remains of brown algae

Some have argued that the presence of graphite in Pre-Cambrian rocks is a sign of the existence of life at this period, but, as Seward points out, graphite occurs in nature in both igneous and sedimentary rocks and some of it is unquestionably inorganic in origin

[19]Invertebrate Paleontology, p 69
[20]Prehistoric Life, p 35

Summing up the present position of the Pre-Cambrian fossil record, Raymond writes "As a matter of fact, the flora and fauna of the Pre-Cambrian, so far as they are recorded by actual fossils, cannot be said, even by the most credulous, to represent more than four groups blue-green algae, brown algae, sponges and annelid worms If paleontologists were called upon for strictly scientific evidence, they could not prove that their determination of any one of these groups is correct"[21]

From this examination of the facts pertaining to the Pre-Cambrian "fossils," we may fairly infer that we have established the truth of the statement with which we began this section "No fossils have been found in the Pre-Cambrian rocks, the earliest fossiliferous strata being the Cambrian, which contain the remains of a rich and varied fauna" So far as we may judge from the evidence provided by palaeontology, life began on earth in Cambrian times, with the appearance of a considerable number of completely differentiated, fully-formed organic types, some of which were rather complex in their structure "Compared with the paucity of fossils in the Proterozoic deposits," writes Professor A F Shull, of Michigan, "the Cambrian has the appearance of pouring out a deluge of living things in great variety As if suddenly, all the principal phyla of animals are represented in the deposits of this period That Cambrian life was not the sudden eruption which it appears to be, is, of course, the view held by biologists in general, for it is regarded as the result of a long period of unrecorded evolution"[22]

The exponents of Extreme Evolutionism have formulated several hypotheses to explain why the long period of evolution demanded by their theory is unrecorded in the strata Raymond devotes six pages to a discussion of six of these hypotheses, including his own, and admits that none of them is satisfactory

The hypothesis that the Pre-Cambrian strata contained fossils that have since been destroyed by metamorphism is unacceptable, because, as Seward and Raymond point out, some of the Pre-Cambrian strata have not been altered by metamorphic agencies Raymond mentions in particular the Beltian of Montana, the Keeweenawan of Michigan, parts of the Huronian

[21]Prehistoric Life, p 32
[22]Evolution, McGraw-Hill, New York, 1936, p 46

of Ontario, and Pre-Cambrian strata in Texas, Newfoundland, and China. Some of these strata are limestones and shales, which differ from later strata only in being devoid of fossils. The obvious explanation seems to be that these strata do not contain fossils because there were no living forms to be preserved as fossils when they were deposited.

Walcott and others have suggested that the Pre-Cambrian forms of life were not fossilized because they were unprovided with hard parts readily capable of preservation as fossils. This explanation cannot stand, for jellyfish have left fossil remains in the Lower Cambrian, and there are no hard parts in jellyfish. Moreover, the marks of raindrops have been preserved in the Pre-Cambrian strata, so there is no reason why the traces of soft-bodied animals should not have been preserved also, if such animals had been in existence. Besides, this hypothesis does not meet the difficulty presented by the sudden appearance in the Lower Cambrian of such forms as the Trilobite, for the Trilobite is a highly developed organism with hard parts, and there is no trace of the many intermediate forms which on this hypothesis would have linked it with the soft-bodied Pre-Cambrian ancestral forms.

The earliest fossils are found, in abundance, in the Lower Cambrian. There are no fossils in the Pre-Cambrian. It certainly looks as if the Lower Cambrian marks the beginning of life on earth—a conclusion which few, we think, would reject were it not for the common assumption that Extreme Evolutionism must be true.

THE SUBSEQUENT SUCCESSION OF ORGANIC LIFE

If the subsequent history of the living world were in accordance with the theories of classical Transformism, we should find new forms of life coming into existence gradually and by a process of gradual change giving rise to various types of descendants. There should be, for example, a considerable number of intermediate forms linking the earliest vertebrates, which appear in the Silurian, with an invertebrate ancestor, and the earliest vertebrate should appear as a single type, which undergoes gradual modification in various ways and produces the different classes of the phylum Vertebrata. The strata should contain many transitional forms, enabling us to trace, at least in outline, the descent of fishes from an invertebrate form, of amphibia from

fishes, and of the various orders of amphibia from the initial, generalized, primitive amphibian, similarly, the other classes of vertebrates—reptiles, birds, mammals—should each arise as a single form, linked by intermediate forms to its parent stock and to its own diversified offspring If this were the picture drawn for us by the fossil record in post-Cambrian strata, it would give a certain plausibility to the contention that the forms of life found in the Cambrian are the product of a long period of unrecorded evolution

The fact is, however, that the manner in which life first appears in the Cambrian represents a pattern that is repeated whenever any new form of life comes into existence in succeeding ages These new forms of life appear in the strata unheralded by any intermediate forms that would enable us to trace their descent from a pre-existing ancestor, they are fully-developed, possessing all the essential features of the new type, and generally they appear in considerable variety G G Simpson, the eminent American palaeontologist, writes "The facts are that many species and genera, indeed the majority, do appear suddenly in the record, differing sharply and in many ways from any earlier group, and that this appearance of discontinuity becomes more common the higher the level, until it is virtually universal as regards orders and all higher steps in the taxonomic hierarchy"[23] The same writer, commenting on the evolution of the horse from *Eohippus,* says "Matthew has pointed out (e g , 1926) that *Hyracotherium* (*Eohippus*) is so nearly a generalized primitive perissodactyl that it could be near the ancestry, if not itself the ancestor of all the later families of perissodactyls Knowledge of a nearly continuous sequence leading to the horses and ignorance of smaller or larger sequences leading to other families (tapirs, rhinoceroses, titanotheres, and so forth), at first closely similar, might be due only to chance But nowhere in the world has any recognizable trace been found of an animal that would close the considerable structural gap between Hyracotherium and the most likely ancestral order, the Condylarthra This is true of all the thirty-two orders of mammals, and in most cases the break in the record is still more striking than in the case of the perissodactyls, for which a known earlier group does at least provide a good structural ancestry

[23]Tempo and Mode in Evolution, Columbia U P , New York, 1944, p 99

The earliest and most primitive known members of every order have the basic ordinal characters, and in no case is an approximately continuous sequence from one order to another known In most cases the break is so sharp and the gap so large that the origin of the order is speculative and much disputed This regular absence of transitional forms is not confined to mammals but is an almost universal phenomenon, as has long been noted by paleontologists It is true of almost all orders of all classes of animals, both vertebrate and invertebrate *A fortiori,* it is also true of the classes themselves and of the major animal phyla, and it is apparently also true of analogous categories of plants "[24]

To appreciate the full import of this statement of Simpson's, it would be necessary to make a complete study of the facts of palaeontology We have space here for only a few examples to illustrate the general rule that organic types appear in the fossil record fully-formed and without any trace of the transitional forms that would enable us to link them with other types

In the **Ordovician**, the Crinoidea or sea-lilies, a class of the phylum Echinodermata, appear for the first time in the strata Not a single Crinoid fossil has been found in the Cambrian, nor is there any trace of fossils that would enable us to trace the descent of the Crinoids from the Cambrian Echinoderms, moreover, the Crinoid fossils found in the Ordovician represent three of the four orders into which the class is divided, and these three orders embrace fourteen families, orders and families all being clearly marked off from one another

The Bryozoa, sea-mosses or moss-animals, are a phylum that is not found in the Cambrian and first appears in the Ordovician Nothing is known of its ancestry, and it is represented in the Ordovician by four of the five orders into which the phylum is divided, these four orders being sub-divided into fourteen families "The evolution of the Bryozoa," write Twenhofel and Shrock, "is not clear The earliest known bryozoan makes its appearance in the early Ordovician, and very soon thereafter four of the five orders appear "[25]

[24]Tempo and Mode in Evolution, p 105
[25]Invertebrate Paleontology, p 247.

Vertebrate animals appear suddenly in the **Silurian** and the impossibility of tracing their descent from any invertebrate phylum is attested by the number of different hypotheses regarding the form from which they are derived—echinoderms, annelids, arthropods, tunicates, and a few more These vertebrates, so different in their structure from the invertebrate phyla, are the Ostracoderms, fish-like animals, somewhat resembling the lamprey "When we first see them," writes Professor A. S Romer, of Harvard, "these ostracoderms have already a long history behind them and are divided into several distinct groups. . . It is surprising to find such highly specialized structures in such an early form, but we must remember that by late Silurian times the vertebrates must already have had a long, even if unknown, evolutionary history behind them"[26] As Romer admits, this long evolutionary history is an evolutionary postulate, unsupported by any fossil evidence We are concerned here with facts, and the fact is that when the vertebrates first appear in the strata they appear in several distinct forms and are already highly specialized In the Silurian, Romer repeats, "all the major groups of ostracoderms are present and are highly developed and diversified They appear to have been then at the peak of their career and to have had behind them a long history, of which, because of the lack of early continental deposits, we know almost nothing."[27] In subsequent strata, other types of fish will come into existence, but they will not be the descendants of the ostracoderms. "The ostracoderms," Romer writes, "were primitive vertebrates, but if we seek among the known forms for the ancestors of higher vertebrate groups we meet with disappointment"[28]

The Placoderms, a higher type of fish than the Ostracoderms, appear suddenly in the **Devonian** strata "Most of the major groups of Placoderms," writes Romer, "appear at the beginning of the Devonian We know little of their antecedents, nothing of any Silurian type which could have been a common ancestor."[29] There are five orders of Placoderms, and no trace of any form that would enable us to link one order with another

[26]Vertebrate Paleontology, University of Chicago Press, 2nd Edn, 1945, pp 25, 28
[27]Ibid, p 515
[28]Ibid, p 35
[29]Ibid, p 59

The bony fishes, which first appear in Mid-Devonian, represent the fish type with which we are most familiar They are sub-divided into two classes, which are "already quite distinct at their first appearance in the fossil record"[30] These also have no recognizable ancestors As Romer puts it, "the appearance of the bony fishes in the geologic record is a dramatically sudden one There are no traces of the group in the Silurian and only a few fragments which may be of Lower Devonian age In the Middle Devonian they appear full-fledged and diversified and at once dominate the scene The initial stages in their development must have taken place long before, quite probably in the upper reaches of river systems from which no deposits have been preserved The common ancestor of the bony-fish groups is unknown"[31]

The cartilaginous fishes, the group to which the sharks and rays belong, first appear in the Mid-Devonian, and there is no sign of any form linking them with the bony fishes or with any other type

"A chronological treatment," Romer writes, "tends only to throw into stronger relief that we know almost nothing of the origin or real relationships of most of the early fish groups"[32]

In the **Carboniferous**, which American palaeontologists divide into two parts—the Mississippian and the Pennsylvanian, the first animals capable of existing on land make their appearance, viz. (1) no fewer than twelve orders of the class Insecta, (2) the spiders, (3) three of the six orders of the class Amphibia, and (4) two orders of the class Reptilia As he studies the Carboniferous fauna, the exponent of Extreme Evolutionism faces enigma after enigma, for the insects and spiders would have to have originated from some aquatic invertebrate, and the insects would not only have learned to live out of water, but would also have acquired wings and at once blossomed out into twelve orders, the amphibians would have originated from some kind of fish and some of them, not long after accomplishing this feat, would have given rise to the reptiles

[30]Vertebrate Paleontology, p 75
[31]Ibid, p 86
[32]Ibid, p 521

If the insects evolved from some aquatic invertebrate, as Extreme Evolutionism maintains, they would have had to acquire legs and tracheae (the special breathing-organs of insects), and also wings, all of which are found in the first fossil insects It is curious that not a single fossil has been found that would enable us to link the twelve orders of insects with a common insect ancestor, or this hypothetical ancestor with any aquatic organism "The Insecta," write Twenhofel and Shrock, "appear abruptly at the beginning of the Pennsylvanian, and immediately develop into a large group and continue as such until the present time"[33] Raymond tells the same story "The oldest insects now known are found in strata of the Alleghany series, which are, next to Pottsville, the oldest rocks of the Upper Carboniferous (Pennsylvanian) system Unfortunately, they are fully-fledged Pterygota, with no indication of the particular group of arthropods from which they sprang Cockroaches and Palaeodictyoptera were the most common Pennsylvanian insects, but considerable differentiation had been achieved at that time, for thirteen orders are represented, all but one (Blattaria) now extinct"[34]

The spiders, like the insects, display great diversity on their first appearance in the strata, and the Carboniferous fossils represent not only most living orders, but three extinct orders as well These early spiders are fully formed, and they have spinnarets similar to those of the modern forms "Spiderlike animals," Raymond writes, "are found in the Lower Carboniferous, and true spiders, as well as various related forms, are known from the Pennsylvanian Nothing is yet known of the ancestry of these groups Almost all modern arachnids are air breathers It is somewhat exasperating that so little is known of their origin"[35]

The three orders of Amphibia, which are sometimes grouped to form a super-order called Stegocephali, are quite distinct from one another and from the other three orders of the class, which are found in later strata No fossils are known that would enable us to link the three orders of Stegocephali with one another or with any common ancestor With the appearance of

[33]Invertebrate Paleontology, p 476
[34]Prehistoric Life, p. 202
[35]Ibid, p 61

these amphibia, the first ambulatory limbs come on the scene, these limbs are perfectly formed and there is no trace of any intermediate structure linking them to the fins of fish, the only organ from which they could possibly have evolved Of course, if the hypothesis of Extreme Evolution be true, there must have been an unknown common ancestor, which would have lived in Devonian times, if not earlier. "Amphibians are abundant and varied in the Carboniferous," Romer writes, "and it is therefore certain that the group originated in the Devonian Until recently, no skeletal remains of amphibians were known from that period, but in the last few years two discoveries have been made which shed light on this earliest chapter of tetrapod history These discoveries are, however, not too satisfactory, for in one case (*Elpistostege*, a skull-roof), the find is definitely Devonian, but doubtfully amphibian, in the other (*Ichthyostega* and *Ichthyostegopsis* from the Palaeozoic of Greenland) definitely amphibian, but doubtfully Devonian"[36] With regard to the latter find, Raymond remarks "The names are supposed to indicate that the animals were fishlike stegocephalians, that is, intermediate between the fish and the ancient amphibians Unfortunately, they are typical four-footed creatures only slightly more fishlike than some of the later members of the group."[37] The origin of the amphibians, therefore, so far as it is known from the fossil record, has the same characteristics as the origin of the fishes as the fish differs profoundly in structure from its hypothetical invertebrate ancestor, so the amphibian differs profoundly from the fish, like the fish, too, the amphibian appears on the scene suddenly and in a number of different forms. After admitting that the existence of amphibians in the Devonian is very doubtful, Romer adds that in the Carboniferous they are highly diversified "The Carboniferous is the time of the greatest development of the amphibians Once evolved, with the possibilities of amphibious, if not terrestrial life before them, they had spread into a host of types varying greatly both in structural features and in adaptations"[38]

In the Upper Carboniferous (Pennsylvanian), the earliest fossil reptiles occur, belonging to two distinct orders, the Cotylosauria

[36]Vertebrate Paleontology, p 143
[37]Prehistoric Life, p 109
[38]Vertebrate Paleontology, p 521

and the Pelycosauria. There are no fossils linking these orders with each other or with any amphibian ancestor. "The development of the reptiles," Romer writes, "primarily characterized by their improved reproductive processes, took place during the Carboniferous. Unfortunately our record of their early history is poor Late Pennsylvanian records show that the reptiles had at that time become as diversified as in the Permian; for we find not only specialized cotylosaurs of the diadectid type, but pelycosaurs—even the peculiar, long-spined *Edaphosaurus*"[39]

In the **Permian** appear three new orders of reptiles, with no transitional forms that would enable us to link them with one another or with the Pelycosauria and Cotylosauria of the Carboniferous These are the Mesosauria, Thecodontia, Araeoscelidia

In the **Triassic** appear five new orders of aquatic reptiles —Nothosauria, Ichthyosauria, Plesiosauria, Thalattosauria, and Chelonia, and two orders of terrestrial reptiles—Dinosauria and Pterosauria. Since these types all differ widely from one another and from any possible ancestors and are well represented in the fossil record, it will be worth our while to consider them a little more in detail The nothosaurs were crawling or swimming reptiles, somewhat resembling lizards, with webbed feet, and varying in size from one to ten feet. The plesiosaurs were swimming reptiles, with a small head, a very long neck, and the digits of the limbs united in a paddle The ichthyosaurs were marine reptiles, with a fish-shaped body, long head and tail, and no distinct neck, in external form they very much resembled dolphins The thalattosaurs were marine reptiles resembling crocodiles The chelonians were the earliest turtles The dinosaurs were long-tailed and long-necked land reptiles, many of considerable, and some of gigantic size, with limbs adapted for habitual support of the body The pterosaurs were flying reptiles, with hollow bones, and in their general structure remarkably like birds

It is clear that these orders of reptiles all differ widely from one another in their structure and there is considerable diversity also in their mode of life They all appear on the scene fully-formed and, as the following quotations show, there is no trace

[39]Vertebrate Paleontology, p 524

of any fossil that would serve as a link to connect them with some ancestral form or with one another

"No species which could have been directly ancestral to any plesiosaur," Raymond writes, "has yet been found"[40]

"Although the Triassic forms of ichthyosaurs were slightly more primitive than their Jurassic descendants," Romer says, "they were already very highly specialized marine types No earlier forms are known The peculiarities of ichthyosaur structure would seemingly have required a long time for their development and hence a very early origin for the group, but no known Permian reptiles are at all suggestive of an ancestral position"[41] And again "There are no clues as to the ancestry of the ichthyosaurs"[42] The same truth was expressed even more forcibly by S W Williston thirty years ago "It may now be truthfully said that of no group of extinct reptiles do we have a more complete and satisfactory knowledge than of the ichthyosaurs Nevertheless, we have yet very much more to learn about the order of Ichthyosauria as a whole—whence they came and how they originated, what their nearest kin were among the reptiles, and especially, more about the connecting links between them and the terrestrial reptiles They have as an order, so isolated a position, and are so widely separated from all other reptiles in structure, that they have long been a puzzle to palaeontologists Like the whales and other cetaceans among mammals, we know the ichthyosaurs well in the plenitude of their power and the fulness of their development, but we have yet only an imperfect knowledge of their earlier history and none whatever of their earliest"[43]

"The Chelonians, or tortoises and turtles," writes K A von Zittel, "form a homogeneous and narrowly circumscribed group, widely separated from all other reptiles They first appear in the Upper Keuper (Triassic) of Southern Germany, exhibiting all the typical characters of the Order, and they do not undergo any noteworthy modification during all their subsequent history"[44] Romer has much the same story to tell "But little light is shed

[40]Prehistoric Life, p 158
[41]Vertebrate Paleontology, p 189
[42]Ibid, p 528
[43]Water Reptiles of the Past and Present, Univ of Chicago Press, 1914, p 112
[44]Textbook of Palaeontology (Tr Eastman), 2nd Edn, Macmillan, London, Vol II, 1932, p 296

on the ultimate origin of the turtles from a study of fossil members of the order. Some early Triassic forms, such as *Triassochelys,* show a structure slightly more primitive than that of most later turtles But even at that time the armor was nearly perfectly developed, we are dealing definitely with a true turtle and not with a transitional type. The ancestors of the group must be sought further back—in Permian times "[45] It is curious that there should be no trace whatever in the fossil record of these hypothetical Permian ancestors of the turtle, whereas, to quote Williston, "the remains of no other air-breathing vertebrates are so omnipresent in the rocks as those of turtles "[46]

There is no trace of any fossil that would enable us to link the dinosaurs with any other form, or the two distinct groups of dinosaurs with any common ancestral type "The dinosaurs," Romer writes, "are divided into two orders, the Saurischia and the Ornithischia, both included in the sub-class Archosauria, but no more closely related to one another than to the other members or descendants of the ruling group—the crocodiles, pterosaurs, or birds The distinctions between the two dinosaurian orders were clean-cut from the first "[47]

Nothing is known of the ancestry of the pterosaurs, true flying reptiles, some of which were as small as sparrows, while others had a wing-spread of 25 feet "Paleontologists are still amazed," Raymond writes, "by the extraordinary history of the pterosaurs Their sudden appearance, so far as the fossil record is concerned, in the Upper Triassic of Europe, is comparable only to their sudden extinction after a brief visit to North America in Mid-Upper Cretaceous times "[48] Von Zittel places the date of their appearance a little later "The earliest undoubted remains of Pterosaurs," he writes, "occur in the Lower Jurassic of Europe, and nothing is known of their ancestors "[49] H G Seeley, who made a lifelong study of the pterosaurs (or, as he calls them, pterodactyles), came to the conclusion that they could not have come into existence by gradual descent from any other type "The hypothesis of

[45]Vertebrate Paleontology, p 183
[46]Water Reptiles of the Past and Present, p 216
[47]Vertebrate Paleontology, p 229
[48]Prehistoric Life, p 164
[49]Textbook of Palaeontology, Vol II, p 423.

descent," he writes, "therefore, becomes impossible in any intelligible form in explanation of the distinctive character of the skeleton."[50] "There is," he adds, "no geological history of the rapid or gradual development of the wing-finger, and although the wing-membrane may be accepted as its cause of existence, the wing-finger is powerfully developed in the oldest known Pterodactyles as in their latest representatives. Pterodactyles show singularly little variation in structure in their geological history."[51]

In the **Jurassic** there appear: (1) the crabs and lobsters, (2) two new orders of amphibians, the Urodela (salamanders, newts) and the Anura (frogs and toads), (3) a new order of reptiles, the Crocodilia, (4) the birds, (5) three orders of mammals (?), whose remains are very fragmentary. No fossils have been discovered that would throw light on the origin of any of these groups.

The two orders of amphibians do not differ much, except in the size of some of the forms, from their living representatives; no fossils have been found intermediate between these orders and the three earlier orders of amphibians, which became extinct before the end of the Triassic. "The earliest frog fossil," Raymond writes, "is so like modern ones that it is obvious that the group originated much earlier. . . . It remains for paleontologists to find in the late Paleozoic and early Mesozoic strata proof of the ancestry of the modern amphibians."[52]

The earliest bird fossils are three specimens from the Upper Jurassic of Bavaria—an isolated feather, a skeleton without head or neck, and a skeleton including both these parts. They have been named *Archaeopteryx* and *Archaeornis*, and they probably belong to the same family and perhaps even to the same genus. They differ in structure from any other known bird, living or extinct. They have a long tail, supported by about twenty vertebrae, each of which carries a pair of feathers. There is a series of thirteen conical teeth on each side of the upper jaw, fixed probably in distinct sockets, and there are also similar teeth in the lower jaw. The metacarpals (bones at the extremities of the wing), unlike those of modern birds, appear

[50]Dragons of the Air, Methuen, London, 1901, p. 226.
[51]Op. cit., p. 229.
[52]Prehistoric Life, p. 116-117.

to have been free, not fused, and each digit is furnished with a claw, projecting beyond the wing. On the other hand, the skull is shaped like that of a typical bird, and the legs and feet resemble those of a crow.

Archaeopteryx and *Archaeornis* are important because they are the only fossils seriously put forward as a connecting link between classes, the classes in this case being birds and reptiles. "We may now stop talking," G Heilmann declares, "about the 'missing link' between birds and reptiles. So much so is *Archaeornis* this that we may term it a warm-blooded reptile disguised as a bird"[53] This is an extravagant statement, which would be repudiated by the great majority even of those who hold Extreme Evolutionism. Romer, for example, writes "*Archaeopteryx* and *Archaeornis* were already definitely birds."[54] "The *Archaeopteryx*," C Depéret declares, "is already, in its structure taken as a whole, a true bird, furnished, without any doubt, with a very long ancestral genealogy, which for the present escapes our observation."[55] B W. Tucker, who says that the reptilian ancestry of birds is self-evident and axiomatic, nevertheless admits that these two forms are "indubitably birds"[56]

Since *Archaeopteryx* had feathers, it was certainly warm-blooded, whereas all reptiles are cold-blooded It has been said that the feathers of birds are a modification of the reptilian scale, but the two structures are profoundly different Raymond, who holds that the birds are probably descended from a branch of the dinosaurs, writes "The same opinion (viz., that feathers are frayed-out scales) has been held by many zoologists and most paleontologists, and the statement that feathers are modified scales appear in most text-books It is only recently that it has been shown that they are fundamentally different structures, arising from different layers of cells in the skin Feathers are as absolutely confined to birds as hair is to mammals"[57]

The features by which *Archaeopteryx* differs from other birds and which are adduced as evidence of its reptilian ancestry are not characteristic of reptiles and are such as may differ in

[53]The Origin of Birds, Witherby, London, p 36
[54]Vertebrate Paleontology, p 262
[55]The Transformations of the Animal World, Kegan Paul, London, 1909, p. 249
[56]The Origin of Birds, in Evolution (Ed G R de Beer), Oxford U P, London, 1938, p 322
[57]Prehistoric Life, p 184

closely allied forms Thus it has a long tail, and most birds have a short one, but some monkeys have tails and others are tailless It has teeth, whereas teeth are absent in all modern birds, but some whales have teeth, and others have none Moreover, teeth and a long tail are not distinctively reptilian features, for the tortoise has no teeth and certain pterodactyls had a short tail But even if it be admitted, for the sake of argument, that the "reptilian" features of *Archaeopteryx* are all as reptilian as Extreme Evolutionism maintains, there still remains an immense gap, unbridged by any fossil, between the earliest known birds and any reptilian form Raymond writes "*Archaeopteryx* and *Archaeornis* lived at a time not far removed from that at which their stock diverged from some reptilian ancestor But what was the ancestor and how was the separation accomplished? No positive answers to these questions can as yet be given We know so little that the most that can be done is to formulate theories and assemble facts to support or contradict them "[58]

The earliest mammalian fossils are a number of teeth and tiny jaws less than an inch long, found in the Jurassic They have been divided into four groups Triconodonta, Symmetrodonta, Multituberculata, and Trituberculata (or Pantotheria) No fossils are known that would serve as a link between these forms and the therapsid reptiles from which the mammals are thought to be descended "By late Triassic times," Romer writes, "the typical therapsids had apparently become extinct In the mid-Jurassic there appear forms which can definitely be classed as mammals Between there lies an evolutionary 'no man's land,' a time when the transition from reptiles to mammals was occurring Unfortunately, our knowledge of this transition is poor "[59]

Of these four groups of Triassic mammals, only one, the Multituberculata, survived in late Cretaceous times, and, according to Raymond, these "were not progenitors of the modern mammals, but form a subclass of their own "[60] The modern mammals are thought to be descended from the Trituberculata, but no fossils are known that would enable us to bridge the gap

[58]Prehistoric Life, p 183
[59]Vertebrate Paleontology, p 289
[60]Prehistoric Life, p 214

between them, and the Trituberculata themselves, as we have said, are known only from jaws and teeth. "It is unfortunate," Raymond remarks, "that so little is known of the skeleton of these animals"[61] Of the gap between the Trituberculata and the modern mammals, Romer writes "Between the Upper Jurassic and the Upper Cretaceous, when marsupials and the first placentals appear, we know but two or three teeth."[62]

In the **Cretaceous**, two new orders of birds appear, the Odontolcae and the Odontormae *Hesperornis,* the best-known of the Odontolcae, with a skeleton over a metre in length, was probably flightless, had teeth implanted in a continuous groove, and hind limbs completely adapted for swimming, as in the existing divers *Ichthyornis,* the best-known of the Odontormae, was a small flying bird, about the size of a pigeon, with teeth in separate sockets No fossils have been found that would link these forms with each other or with any preceding or subsequent group The difference between the arrangements of the teeth in the two groups is not easy to account for on the hypothesis that all birds are derived from a common ancestor

In the Cretaceous also, the first marsupial and placental mammals appear *Eodelphis,* the oldest true marsupial, is an opossum; the placentals are known from a few small skulls found in Mongolia, and they seem to be related to the modern Insectivora, an order of which shrews, moles and hedgehogs are familiar examples As we have said, there are no fossils linking these with any earlier group

In the earliest Tertiary strata, the **Basal Eocene,** or **Palaeocene,** sixteen of the twenty-eight orders of Tertiary and Recent mammals, according to Raymond, have been found[63] Three of these, the Multituberculata, Marsupialia, and Insectivora, survived from the Cretaceous, and the remainder are new arrivals on the scene No fossils are known connecting the thirteen new orders with one another or with any ancestral form The sudden appearance in the strata of such a wide variety of new forms is difficult to reconcile with any theory of gradual evolution, and those who regard evolution as normally a slow, gradual process, are compelled to admit that it must have

[61]Prehistoric Life, p 215
[62]Vertebrate Paleontology, p 309
[63]Prehistoric Life, p 222

been extremely rapid in the early Eocene. Thus J. B. S. Haldane speaks of "the slowness of natural selection," which he regards as probably "the main cause of evolutionary change in species as a whole," and of "the slow and steady evolution to which the geological record bears witness," and nevertheless affirms that "the distinction between the principal mammalian orders seem to have arisen during an orgy of variation in the early Eocene."[64] It is difficult to see how an "orgy of variation" can be reconciled with a theory of slow and gradual evolution.

The presence of bats, which differ widely from all other mammals in their skeletal structure, constitutes a particularly difficult problem for any theory of gradual evolution. "The rapidity of diversification among the mammals at the beginning of the Tertiary," Raymond writes, "is made evident by the appearance of flying mammals—the bats—at that time. It is true that only a single imperfect upper jaw has yet been found in the Paleocene (this in Colorado), but more and better-preserved specimens, even those retaining wing-bones, are known from the European Eocene."[65] No fossil has been found connecting the bat with any other animal, despite the enormous difference between the limbs of the bat and those of other mammals, and the abundance of mammalian fossils in the epoch in which the bats first appear.

The earliest Primates, belonging to the Lemuroidea and Tarsioidea, are found in the Eocene. Their ancestry is unknown and no fossils are known that would link them with the monkeys and anthropoid apes, which do not appear until much later.

The first representatives of the orders Cetacea (whales, etc.) and Sirenia (dugongs, etc.) appear in the middle and later Eocene. Although these animals are commonly held to be descended from land mammals, intermediate fossils are quite unknown.

Birds of the modern type also appear suddenly and in considerable variety in the Eocene, e.g., penguins, divers, gulls, flamingoes, geese, herons, cormorants, pheasants, hawks, owls, woodpeckers, sparrows. The groups are quite distinct, there being no intermediate forms that would enable us to link them with one another or with any ancestral type. "Toothed forms

[64]The Causes of Evolution, pp. 95, 137, 107, 104.
[65]Prehistoric Life, p. 223.

of birds appear to have become extinct by the end of the Cretaceous," Romer writes, "and except for some tropical types, almost every large group of modern birds, and even most of the major families, were already present in the early Tertiary"[66]

Although a number of new forms make their appearance in the strata in subsequent epochs, e.g., the aquatic carnivores and the whalebone whales in the Miocene, and man in the Pleistocene, the animal world has not since the Eocene undergone any such spectacular changes as that epoch witnessed, and so we can at this point bring to a close our survey of the history of animal life

When we examine the history of the plant world, we find that the same phenomena are to be observed there as in the animal kingdom The simplest plants appear first and the most highly developed, the flowering plants, are the last to come on the scene Each large group, however, as in the case of the animals, appears in the strata fully-formed and unheralded by any transitional forms that would enable us to trace its descent from some other group

There is no real evidence of plant life in the Pre-Cambrian strata "The latter part of the Pre-Cambrian era," Seward writes, "is often spoken of as an Age of Algae, a title based on unsubstantial evidence which, as we give rein to our fancy, assumes a disproportionate importance"[67]

There are definite plant fossils from the Cambrian onwards "For the most part," Seward writes, "the plants obtained from the rocks of the three older Palaeozoic periods (Cambrian, Ordovician, and Silurian) are members of the class Algae (to which the seaweeds belong)"[68] After discussing the various fossils that have been found, he concludes "This brief summary, deliberately incomplete as a description of genera, may suffice to emphasise one point the comparatively slight difference in their broader features between some of the older Palaeozoic Calcareous Algae and algae which are still living"[69]

The earliest land plants are found in the Devonian, appearing fully-formed, and in considerable variety, and there are no fossils that would enable us to trace their descent from the algae that

[66]Vertebrate Paleontology, p 549
[67]Plant Life through the Ages, p 515
[68]Ibid, p 101
[69]Ibid, p 108

existed in the preceding periods "For the present," Seward writes, "it is consistent with fact to say that in the course of the Devonian period a varied and highly organized vegetation took possession of the land and some of its members spread from one end of the world to the other Whence it came and what were its antecedents are questions that cannot yet be answered"[70] It is worth noting that in this Devonian flora the plants are seed-bearing, and more highly organized than the Ferns, which were at one time thought to be their ancestors but do not in fact precede them in the fossil record "On a review of the whole evidence," writes D. H Scott, "the former belief in the origin of the Pteridosperms (and through them of the Seed-plants generally) from Ferns must be given up We have no reason to believe that Ferns, as botanists understand the name, are any older than the Pteridosperms themselves"[71]

In the subsequent periods, new forms appear and the transitional forms required by the classical theories of Extreme Evolutionism are all missing "Two distinguished French palaeobotanists, now deceased, Grand'Eury and Zeiller," writes Scott, "were led, chiefly by their extensive observations of the older fossil floras, to the belief that the change from one species to another was not gradual, but sudden Zeiller went further, and held that the idea of mutation, of discontinuous evolutionary series, should be extended to groups of a higher order than species He said that this discontinuity was shown, whatever the rank of the groups examined"[72]

A striking instance of the sudden appearance of a new type of plant is furnished by the Angiosperms, or flowering plants, which come on the scene in Cretaceous times "The geological history of the angiosperms," writes D H Campbell, "is very incomplete In the Lower Cretaceous many fossils have been found, but nearly all of these are related to living genera and are even referable to them, e g, *Ficus, Platanus*, and *Sassafras* It is evident that there must have been a long line of more primitive ancestral forms, presumably extending into the Jurassic, but as yet they have not been discovered"[73] Seward puts the facts

[70] Plant Life through the Ages, p 112
[71] Extinct Plants and Problems of Evolution, Macmillan, London, 1924, p 207
[72] Ibid, p 30
[73] The Evolution of the Land Plants, Stanford Univ Press, 1939, p 542

more bluntly "At this point (i.e, between the earlier and later Cretaceous) another transformation occurred, again with a suddenness that is not merely apparent because of the imperfection of our knowledge, but actual the colour scheme was substantially altered by the introduction of a new decorative feature the rise to pre-eminence of the flowering plants which appears as a new creation."[74]

The flowering plants are divided into two groups—Monocotyledons and Dicotyledons Both groups are quite distinct from the beginning of their history—there is no evidence of their descent from a common ancestor "The record shows no time-limit between Monocotyledons and Dicotyledons," Scott writes, "and throws no light on the possible derivation of one class from the other Both extend far back into the Cretaceous, and throughout the whole time the Dicotyledons appear more numerous than the Monocotyledons, as they are at the present day"[75] He then goes on to point out how "even in detail, the structure of Cretaceous Palms was quite modern." He adds "The early development of this great and advanced Monocotyledonous family shows how far we must be from tracing the Flowering Plants to their origin" After mentioning some other examples, he concludes "Enough has been said to show that very diverse families of Monocotyledons were already present, in their typical form, well back in the Cretaceous Period, that is, almost as soon as the Monocotyledons appear in the strata The Dicotyledons found in the Cretaceous include Willows, Poplars, Bog Myrtles, Peppers, Walnuts, Beeches, Oaks, Breadfruit, Waterlilies, Magnolias, Laurels, Planes, Eucalypts, Maples, Ebony, Ash, and Oleanders" Scott concludes his account of these fossils "If we judge by present evidence, it would not be surprising to find that by about the middle of the Cretaceous period the Angiosperms generally were developed much as they are now, so far as the families and even some of the genera were concerned"[76] Since Scott holds a theory of Extreme Evolutionism, he assumes that the Angiosperms had a long line of ancestors, still undiscovered, in pre-Cretaceous times He writes "The class had already, in lower Cretaceous times, attained a

[74]Plant Life through the Ages, p 520
[75]Extinct Plants and Problems of Evolution, p 43
[76]Ibid, p 52

high and characteristic development in various directions It is evident that the really early evolutionary stages of the Dicotyledons (and doubtless of the Angiosperms as a whole) must have been traversed in periods long previous to those from which their first recognisable traces have come down to us "[77]

It is clear from this brief account that the succession of forms in the plant kingdom reproduces the features with which we have become familiar in our study of the historical development of animal life Each of the principal types of plants appears in the fossil record suddenly, with all its characteristic notes, and separated by a well-defined gap from the types that most resemble it, and once the type appears, it does not undergo any notable change in the subsequent course of its history "Persistence of type," says Seward, "and from time to time the apparently sudden influx of new types, rather than a steady progressive development, are among the outstanding features of the history of plant-evolution "[78]

If the classical theories of Extreme Evolutionism were true, palaeontological discovery should have brought to light great numbers of intermediate forms linking the main groups of plants and animals with one another Instead, none of these forms have been found A few fossils, such as the bird *Archaeopteryx*, the reptile *Scymouria*, and the cetacean *Zeuglodon*, have been claimed as intermediate forms, but as Radl remarks "The fate of intermediate forms has always been the same Discussion has raged around them for a time, but eventually they have been included in one of the established groups. The belief that such forms ever existed has been abandoned "[79] Berg makes the following comment on the absence of transitional forms "It is truly remarkable that palaeontology in no way displays transitional forms between phyla and classes, and possibly not even between orders Thus we are ignorant of transitional forms not only between vertebrates and invertebrates, fishes and tetrapods, but even between cartilaginous and higher fishes, in spite of a wonderful affinity between reptiles and birds, no transitional forms are known between them hitherto Formerly, this circumstance was accounted for by the imperfection of the

[77]Extinct Plants and Problems of Evolution, p 56
[78]Quoted in Scott, op cit, p 215
[79]The History of Biological Theories, p 178

geological record, but it is none the less surprising that, the deeper our knowledge penetrates into the realm of fossils, the further back recede generic inter-relations, which, as it were, ever elude our grasp True, we know a number of groups that exhibit in their structure an intermingling, as it were, of peculiarities of two different classes or orders, such groups are generally alleged to be transitional. . But a more careful examination reveals that in all cases terminal branches of evolution are represented, and not the transitional forms so eagerly sought for."[80] Simpson, speaking of the continuous transitional sequences between the higher systematic categories, says "Their absence is so nearly universal that it cannot, offhand, be imputed entirely to chance, and does require some special attempt at an explanation, as has been felt by most paleontologists"[81] This agrees with the observation made forty years ago by Depéret "The keenest partisans of the descent theory must acknowledge that the fossil links between the classes and orders of the two kingdoms exist in infinitesimally small numbers."[82]

There are vast numbers of fossils in the crust of the earth According to Raymond, "fossils occur almost everywhere. They may be expected in any region of unmetamorphosed sedimentary strata, and if one looks at a map of N America, he finds that such rocks cover a much greater area than those of igneous or metamorphic origin Fossils are not therefore rare, but occur in inexhaustible numbers."[83] Since the transitional forms between the great groups that are required by the classical theories of gradual evolution are not to be found in this vast assemblage of fossils, it seems evident that they never existed

PALAEONTOLOGICAL PROOFS OF GRADUAL EVOLUTION

"The theory of descent," writes Depéret, "rests to some slight degree on palaeontological facts. The most solid argument consists, as Neumayr had already said, in the series of similar species which can be followed from individual to individual through geological formations and show at least the probability

[80] Nomogenesis, p 347.
[81] Tempo and Mode in Evolution, p 105.
[82] The Transformations of the Animal World, p 113
[83] Prehistoric Life, p 12

of a phylogenetic descent"[84] Neumayr showed how it was possible to trace through a fossiliferous deposit 300 feet in thickness the evolution of nine species with complicated shells from one species with a smooth shell "The most striking genealogical series," writes Depéret, "is furnished to us by the researches of Neumayr and Paul on the *Paludina* of the Levantine fresh-water strata of the Danubian Basin The *Paludina* or *Vivipara* are fresh-water molluscs which dwell in large numbers in our rivers and lakes, their shells have the form of somewhat lengthened spirals with convex whorls devoid of all ornament. In the Pliocene lacustrine strata there are found, at the bottom of the series, Paludines with smooth whorls similar to the existing types, when found in the rather younger strata, the whorls of the spiral of the Paludines become flattened, then hollow out with a flattened median line, with a tendency to a carina (keel) becoming more and more marked at the top of each coil, then a second carina appears at the base of the spiral whorl, finally each of these carinas becomes denticulated and bristles with increasingly distinct tubercles in the higher strata of the formation"[85] Waagen has established a similar evolution in a group of Ammonites, and, says Depéret, "one can describe similar series more or less close to each other in the Camelidae, the Suidae and Ruminants among Mammals, in the Crocodilians among Reptiles, and in the Amiadae and the Physostomes among Fishes"[86]

Perhaps the most famous evolutionary pedigree is that which purports to trace the descent of the modern horse from *Eohippus* of the Eocene, through no fewer than seven genera Professor A. M Davies says that the pedigree of the horse is more usually quoted because the horse is the more familiar animal[87] In reality, the horse is chosen because in its case the evidence is stronger It should be noted, however, that the pedigree of the horse has not been established with certainty The facts are that in the Eocene there lived at least three genera of horses (*Eohippus, Orohippus, Epihippus*), which were small animals, with four toes on the front limbs and three on the rear, and possessing low-crowned teeth In the Oligocene there lived at

[84]The Transformations of the Animal World, p 112
[85]Ibid, p 68
[86]Ibid, p 112
[87]Evolution and Its Modern Critics, Murby, London, 1937, p 51

least two other genera of small horses (*Mesohippus, Miohippus*), having three toes on each foot and long-crowned teeth. In the Miocene there lived seven or more genera of large horses, having three toes on each foot and long-crowned teeth; some of these lived on into the Pliocene, when other genera appear, having the side toes reduced to splints, as in the modern horse. Some of these are probably the ancestors of *Equus*, the living horse, but this has yet to be proved, for the connecting fossils have not been found Depéret declared that "the supposed pedigree of the *Equidac* is a deceitful delusion, which simply gives us the general process by which the tridactyl hoof of an Ungulate can transform itself, in various groups, into a monodactyl hoof, in view of an adaptation for speed; but it in no way enlightens us on the palaeontological origin of the Horse"[88] Even Raymond is rather cautious in his appraisal of the evidence "Eight genera," he writes, "show characteristics which illustrate the stages intermediate between *Eohippus* and the modern genus *Equus* Many other kinds of horses are known, but these suffice to demonstrate the chain of significant changes"[89]

It will be noticed that the evolutionary changes of which these series of fossils are evidence have remained within comparatively narrow limits. Discussing the evolution of mammals during the Eocene, Von Zittel remarks that "as a rule, no gradually increased branching from one type is found, as might be supposed, but many species in one genus arise simultaneously, and these then form parallel lines of development. . . In contemplating these parallel lines of development, it is particularly surprising to find, in Europe at least, the origin of a new genus from geologically older genera exceptional"[90] Von Zittel remained an Extreme Evolutionist, but admitted that he found the facts surprising Depéret, who also continued to profess his belief in Extreme Evolutionism, was led to a conclusion only a little more favourable to the theory. "The species and genera thus formed by the direct and normal evolution of a branch," he wrote, "always remain very closely related to each other, and

[88]The Transformations of the Animal World, p 105
[89]Prehistoric Life, p 254
[90]Textbook of Palaeontology, Vol. III, 1925, p. 295

do not present differences considerable enough for them to be ranked as distinct natural families "[91]

The differences between the last *Paludina* and the first in Neumayr's series are only superficial and the palaeontologist has no hesitation in placing them in the same natural family *Eohippus* is a small animal about the size of a fox, with four toes on the front feet and three on the hind and with low-crowned teeth, whereas the modern horse is not only much larger, but has a one-toed hoof and high-crowned teeth, but no one doubts that *Eohippus* is a member of the horse family "*Eohippus* of the Lower Eocene, and *Mesohippus* of the Oligocene," wrote Vialleton, "despite the fact that their feet have more than one toe, are easily recognizable, by their gracefulness, the length of their limbs, so different from those of the other perissodactyls (tapirs, rhinoceroses), as also by the form of the head and of the body, as representatives of the family *Equidae*"[92] Consequently, even if the descent of the modern horse from *Eohippus* were as well established as some exponents of Extreme Evolutionism maintain, this would simply mean that one horse is descended from another—admittedly differing in many respects, but still a horse The real problem—the origin of Eohippus, the earliest horse—remains untouched Moreover, the solution of this problem seems as far away as ever, for, as Simpson points out, "nowhere in the world has any recognizable trace been found of an animal that would close the considerable structural gap between *Hyracotherium* (*Eohippus*) and the most likely ancestral order, the Condylarthra "[93]

THE IMPERFECTION OF THE GEOLOGICAL RECORD

Darwin devoted a chapter of his book, *The Origin of Species*, to explaining the absence of intermediate forms by the imperfection of the geological record and our limited knowledge of this record, ending the chapter with these words "For my part, following out Lyell's metaphor, I look at the geological record as a history of the world imperfectly kept, and written in a changing dialect, of this history we possess the last volume alone, relating to only two or three countries Of this volume,

[91] The Transformations of the Animal World, p 269
[92] Morphologie Générale, p 682 Quoted in Dewar, Difficulties of the Evolution Theory, Arnold, London, 1931, p 107
[93] Tempo and Mode in Evolution, p 105

only here and there a short chapter has been preserved; and of each page, only here and there a few lines. Each word of the slowly-changing language, more or less different in the successive chapters, may represent the forms of life, which are entombed in our consecutive formations, and which falsely appear to have been abruptly introduced On this view, the difficulties above discussed are greatly diminished, or even disappear"[94]

A. R Wallace put the issue clearly when he wrote· "The theory of evolution absolutely necessitates the former existence of a whole series of extinct genera filling up the gaps between the isolated genera which in many cases now alone exist proofs of such former continuity are continuously being obtained by the discovery of allied extinct forms, but the extreme imperfection of the geological record as regards land animals renders it improbable that this proof will be forthcoming in the majority of cases The notion that, if such animals ever existed, their remains would certainly be found is a superstition which, notwithstanding the efforts of Lyell and Darwin, still largely prevails among naturalists, but until it is got rid of, no true notions of the former distribution of life upon earth can be attained."[95]

This theme has been enlarged upon by the followers of Darwin ever since, and "the imperfection of the geological record" still comes pat to explain the absence of all those transitional forms that the theory postulates We find Julian Huxley, for example, writing that "in view of the imperfections of the fossil record, it is often very difficult to push the history of a given line back beyond the point at which the first obvious signs of its characteristic specialization appear"[96]

Let us suppose, for the sake of argument, that the fossil record and our knowledge of it are as incomplete as the Darwinians and other exponents of gradual extreme evolution contend What these evolutionists cannot explain is the great disparity between the imperfect fossil record their theories require and the imperfect fossil record that we know Since fossilization and the discovery of fossils are largely governed by chance, the character of the fossil record as it is known to us will be

[94]The Origin of Species, p 271
[95]Island Life, 3rd Edition, Macmillan, London, 1902, pp 70-71
[96]Evolution, the Modern Synthesis, p 488

governed substantially by the ordinary laws of probability, as all admit If, then, as these theories hold, the intermediate forms have been more numerous than the forms, now isolated, which they joined, we should, in accordance with the laws of probability, find more intermediate forms than isolated forms in the fossil record So far is this from being the case that, as we have seen, intermediate forms that would enable us to link the major groups are always missing A great many intermediate forms would be required, for example, to fill the gap between the Turtles and any other reptilian order Thousands of fossils of turtles have been discovered, but of those intermediate forms, which would have had an equal chance of fossilization with the Turtles, and should theoretically be even more numerous in the fossil record, not a single specimen has been discovered From the absence of vertebrate fossils in Cambrian strata, of angiosperm fossils in Carboniferous, of *Equus* fossils in Eocene, the Darwinians conclude, quite correctly, that these types did not exist during these periods By a similar process of reasoning, and with much greater cogency, we conclude, from the absence of all transitional forms from the fossil record, that these forms have never really existed

We still have to inquire, however, whether the fossil record and our knowledge of it are really so imperfect as the Darwinians allege

The record itself would seem to be fairly complete, for although an animal can be preserved as a fossil only if it becomes buried soon after death, the chances are greatly in favour of the fossilization of some individuals of every genus having a skeleton or shell The population of a genus may vary a great deal, but it is rarely less than a million, and the existence of a genus often extends through millions of years The odds are greatly in favour of some of these individuals becoming fossilized during these millions of years Sudden burial may result from sandstorms, floods, the rain of volcanic ashes, immersion in lakes of pitch, bogs or quicksands, avalanches, landslides Such calamities are not infrequent, and it is almost certain that many individuals of every genus must have been overtaken by them during the long period of the existence of the genus to which they belong Moreover, even if the strata in which they were fossilized are worn away by the action of wind and water, the

fossilized parts will often be preserved in new deposits as isolated bones

Our knowledge of the fossil record is of course very incomplete, because so much of the surface of the earth is covered by the sea and only a small part of the land areas of the world have been explored by palaeontologists Nevertheless, a great deal of palaeontological exploration has been carried out since Darwin's day, in nearly every country in the world Consequently, although there is still much territory containing undiscovered fossils, the fossils that have been found are from widely separated areas, and they probably give us the main outlines of the history of living forms in past ages "The known fossils," write Twenhofel and Shrock, "are believed to portray correctly in its broader outlines the life of ancient times, and it is thought that more extensive knowledge will do little more than add detail to the grander picture already outlined"[97] Romer shares this view "It is probable," he says, "that there may have existed many interesting vertebrate types of which no remains have as yet been discovered But such probabilities are decreasing as our knowledge expands During the present century a very great amount of paleontological work has been done and many strange forms have been brought to light These, however, have been almost always members of groups already known or forms tending to connect such groups"[98] As we have seen, the groups connected by such forms are the lower systematic categories, such as species and genera, not the higher categories —phyla, classes, or orders

Douglas Dewar has pointed out that if the mammals now living in India are compared with the fossil record, it will be found that, of the 116 genera now living, fossils of 61 have been found in that country Of the genera that have not yet been found in the fossil state, 13 are small bats, 8 are mice and shrews, and 3 are small members of the rat family, and small fossils are liable to be overlooked Of the others, 7 are aquatic genera, and 5 are very similar to genera that have been discovered Moreover, many of the living genera may have a long life ahead of them, with plenty of opportunities for being preserved as fossils

[97]Invertebrate Paleontology, p 5
[98]Vertebrate Paleontology, p 510

The same author has shown that, of existing land mammals, the European types are fully represented in the fossil record, while in North America the percentage of representation is 90, in South America 72, in Asia 70, in Africa 49, and in Australia 45 These figures show that neither the fossil record, nor our knowledge of it, are so imperfect as the Darwinians allege

Since the consistent absence of transitional forms cannot be accounted for by the imperfection of the record, those who hold Extreme Evolutionism have been compelled to look for other explanations of this phenomenon Depéret explained the sudden appearance of new forms as evidence of migration He wrote "Just as we have seen branches at their highest point end by abrupt extinction, so it seems that the majority of them appear abruptly and complete, as if they had been created altogether in the region under observation This apparent arrest at the outset of evolution of each branch is explained by the sudden arrival of the group in the region of the globe under study"[99] This hypothesis would be plausible enough as an explanation of the sudden appearance of one or a few groups, but it cannot account for the sudden appearance of all the larger plant and animal groups In no case in which an altogether new type appears has there been found in any part of the earth a fossil indicating that this new type has evolved from another, and consequently, on Depéret's hypothesis, we should have to assume that all the important steps in the process of evolution took place in areas that have not yet been geologically explored This assumption is an appeal to the unknown, with no scientific evidence to support it, and it may be dismissed without further discussion

H F Osborn, an American palaeontologist, put forward a theory of what he called "adaptive radiation," according to which each new type would have given rise suddenly to divergent and radiating lines of offspring, each line would adapt itself to its new surroundings, and thus in a short time the original type would be represented by widely different forms The theory is unsatisfactory for several reasons First, it does not explain the origin of the new type, e g , the primitive reptile or mammal Secondly, it cannot indicate any cause capable of effecting the

[99]The Transformations of the Animal World, p 280

rapid and profound transformations that the type would undergo, e g , in giving rise to the various orders of mammals Finally, the theory requires a number of intermediate forms, and these are not forthcoming Julian Huxley seems to think he can combine this theory of adaptive radiation with a theory of slow and gradual evolution by natural selection [100]

G R de Beer, an English embryologist, has put forward a theory of "clandestine evolution," according to which evolution would have taken place in the organism in its young (embryonic or larval) stages of development, such an evolution would be "clandestine" because it would leave no traces in the fossil record After this evolution had gone a certain distance, the young would suddenly have become sexually mature, there would now be a wide gap between the adult forms of progenitor and offspring, and since it is usually adults that are preserved as fossils, this would account for the gaps in the fossil record A few facts can be quoted in support of this hypothesis, but they are very far from providing it with an adequate foundation. Furthermore, it would not explain the total absence of fossils between the great groups

Others have been led by the gaps in the fossil record to put forward the theory that evolution took place by a series of immense mutations, by such a mutation, for example, as the production of a mammalian offspring by reptilian parents, or of a cetacean by terrestrial ungulates This theory also is unsatisfactory, because no natural cause is known that is capable of effecting such an instantaneous transformation.

Although we have yet to consider the evidence bearing on evolution brought forward by the other biological sciences, we may even now, after this brief survey of the facts of palaeontology, draw some conclusions In the first place, it seems clear that within certain limits, extending perhaps as far as the family or the order, there has been a good deal of gradual evolution in the course of ages Secondly, it is quite certain that the plant and animal kingdoms have not originated by gradual evolution from a single stock Evolution of this kind would have required a vast number of transitional forms linking the major systematic groups, if these forms had really existed, they would have left some trace in the fossil record, but

[100] Cf Evolution, the Modern Synthesis, pp 496, 500

there is no trace of them in the fossil record The fossil record is indeed imperfect, but this imperfection does not account for the *consistent* absence from the record of precisely those forms that are crucial to the theories of extreme evolution by gradual change A phenomenon so regular is not to be explained by the essentially fortuitous imperfection of the fossil record Against such theories as those of Lamarck and Darwin the evidence of palaeontology is quite decisive

FACTS DRAWN FROM OTHER DEPARTMENTS OF BIOLOGY

i General Biology
ii Comparative Anatomy
iii Embryology
iv Genetics
v Biogeography
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vii Parasitology
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GENERAL BIOLOGY

All living bodies, whether plant or animal, are composed of one or many cells The cell consists of a jelly-like material called protoplasm, and, as a rule, it is surrounded by a membranous wall and contains a well-defined nucleus or globular mass, which is also surrounded by a membranous wall The multicellular organism begins life as a single cell and develops by the spontaneous formation of two cells from the initial cell, and of two more cells from each of these, and so on, until the organism is complete

This is a summary of what is sometimes called "the cell-theory" It is in reality no theory, but a statement of well-established facts

The animal kingdom, considered under the aspect of its cellular composition, possesses a fundamental unity, and there is a similar unity in the plant kingdom, indeed, if we consider both kingdoms together, we see a still deeper unity From this the exponent of Extreme Evolution infers that all living things are descended from a primitive single cell Of the descendants of this cell, some have remained unicellular, while others have acquired the power of multiplying in such a way as to form multicellular organisms, and these have gradually become differentiated, giving rise to the various groups of plants and

animals that constitute the organic world. From the fundamental similarity of all living bodies—all are cellular and all begin life as a single cell—we are to infer that they are all sprung from a single ancestor, a primordial cell

This evolutionary argument rests on a grossly nominalistic conception, viz, the identification of two quite different things to which the same name is applied—the unicellular organism and the cell of a multicellular organism By a process of abstraction, the biologist considers certain features that are common to the unicellular organism and the cell of a multicellular organism, and only too often regards this abstract concept as the representation of a concrete object, "the typical cell," affirming that the cell is the elementary biological unit The truth is that the typical cell—a little mass of protoplasm individualized by a nucleus—is incapable, if reduced to the general organization common to every kind of cell, of constituting even the simplest kind of organism, in order to form such an organism, the cell must be endowed with supplementary parts, too diverse to be included in the general definition of the cell Hence we deny that the cell is the elementary biological unit or has the role of first model or initial form of organism The elementary biological unit is not the cell, but the organism, unicellular or multicellular as the case may be "Biology," writes E S Russell, "is essentially the study of individual living organisms the individual organism, whether unicellular or multicellular, is the unit to which all biological concepts and laws must relate "[101]

The cells of a multicellular organism are only parts of an organism, not organisms "The living creature," Sherrington declares, "is fundamentally a unity In trying to make the 'how' of an animal existence intelligible to our imperfect knowledge, we have, for purposes of study, to separate the whole into part-aspects and part-mechanisms, but that separation is artificial It is as a whole, a single entity, that the animal, or for that matter, the plant, is finally and essentially to be envisaged."[102] The organism is the unit, and the cells are not units, but only parts of this unit

The unicellular organism, on the other hand, is not merely a cell, because such an organism, e g, the amoeba, has a special

[101]The Interpretation of Development and Heredity, p 173
[102]Pres Address to Brit Assn, 1922 Quoted in Russell, op cit, p 166

form over and above that which belongs to it as a cell, it possesses special parts, such as pseudopods, which are the seat of definite functions, and cannot be covered by the concept of "cell" The amoeba is a specific form of life no less than the elephant "The fact that unicellular organisms live and develop and reproduce as individuals," writes E S Russell, "is quite enough to show that they must be regarded primarily as organisms and only incidentally as cells But the influence of the cell-theory has been powerful enough to obscure this obvious conclusion, it has led to the unicellular organism being regarded as the equivalent of the tissue cell of the higher forms, and to the Metazoon being looked upon as a colony of differentiated cells, each homologous with a Protozoon "[103]

Since the organization of unicellular beings contains much more than can be expressed by the notion of "cell," and the cells of multicellular beings are only incomplete parts of the organism it follows that the cell is an abstraction, and does not represent any common nature existing outside the mind, but only an elementary aspect or feature in which living beings resemble one another When, therefore, the Extreme Evolutionist declares that all forms of life are descended from a simple undifferentiated cell, he falls into the fallacy of treating a mere abstraction as a concrete reality Furthermore, there is no evidence that an undifferentiated cell ever existed, i e, a cell possessing only those features that are common to every kind of cell, and from what we know of organized beings it seems that no such cell could have existed, for the exercise and maintenance of life seems to require a greater degree of organization than would be found in an undifferentiated cell

The physical basis of life is protoplasm, a generic name for the semi-liquid living matter that absorbs food and by its decomposition provides the energy required for other vital functions However, to argue from the protoplasmic character of living matter to the genealogical relationship of all living bodies is no less fallacious than to draw the same conclusion from their cellular character Protoplasm is never found in an amorphous state, but always possesses differentiating features that multiply and enrich its properties It is always the protoplasm of a distinct and definite form of living thing which has

[103]The Interpretation of Development and Heredity, p 236

a determinate role and a special place in nature, and its chemical composition differs widely from species to species, and even from cell to cell in a single individual The similarity among living bodies arising from their protoplasmic character seems to be adequately accounted for by the necessity of having a substance of this consistency in order to exercise the functions of organic life Life is a condition of unstable equilibrium, so that living matter, while possessing a certain stability, must be able to absorb and excrete non-living matter easily, to do this, it should, it seems, be neither completely solid nor completely liquid, but have the consistency of jelly

The fact that the multicellular organism begins life as a single cell does not prove, nor even strongly suggest, that it is descended from a unicellular ancestor The power of reproduction is an essential feature of the living body,—every living body has the power of producing an offspring that shall embody its specific characteristics and some of its individual idiosyncrasies In the case of the multicellular organism, the offspring often takes a long time to mature and needs the care of the parent, or it may be necessary for the parent to produce many offspring, in either case, reproduction must be so effected that the formation of the body of the offspring does not make too great demands on the tissues or strength of the parent This requirement is met by the origin of the offspring from a germ-cell, which contains, as it were, the quintessence of the parent and gradually develops into an organism possessing all the characteristic features of the parent

To conclude, the cellular composition of living bodies does not give any real ground for the conclusion that they are all descended from a common ancestor The concept of the living cell is a mere abstraction, representing an aspect of living matter, but with no concrete reality corresponding to it in nature This concept cannot provide us with an understanding of the world of living things because their cellular composition is a fact of only secondary importance The primary fact about living bodies, whether unicellular or multicellular, is that each of them possesses a determinate specific nature and is a single entity, adapted to a determinate form of vital activity Sometimes this activity is compatible with the possession of protoplasm that is continuous, and then we have the unicellular being, sometimes,

the vital activity calls for the possession of protoplasm that is discontinuous and diversified, and then we have the multicellular being The multicellular organism is not a multitude of juxtaposed entities, the cells, but a single entity, whose vital activities demand that its protoplasm be diversified and contained in well-defined compartments which have a certain broad resemblance to one another and are given the name of cells The atomistic conception, according to which the organism is simply a multitude of cells, has been and still is held by great numbers of biologists It is not, however, arrived at by an inductive analysis of the facts of biology, but is a deduction from the postulates of mechanistic philosophy, and, as Radl notes, it has kept biologists from attacking the real problems presented by the cell—why bodies are composed of cells, why the cell has a nucleus, etc The sooner this conception is abandoned, the better for biology

COMPARATIVE ANATOMY

The science of comparative anatomy provides us with a great deal of material bearing on the problem that concerns us here We shall consider first the structural similarities between organisms that are commonly brought forward as proof of their common origin, dealing in turn with characters and homology Then we shall examine correlations, or the reciprocal relations that exist between the different parts of the same organism. Finally, we shall discuss the existence of "vestigial organs"

Characters The different groups of living things are distinguished from one another by certain easily recognized traits of structure or form that are so constant for each group that they are regarded as true distinguishing notes, or characteristic features of the group in question, its "characters" Of course, it is not easy to tell whether some detail of bodily structure is a character, for later discoveries may show that a feature thought to be peculiar to some group is found also in some totally different group The task of determining true characters has been made more difficult by Extreme Evolutionists who, asserting that a certain feature characteristic of one group is found in members of another group, have inferred from this that the two groups are allied by ties of kinship, whereas the true explanation of the resemblance is quite different

Pectoral mammae, for example, have been regarded as a character of the Primates (man and the monkey tribe) They

are found also in bats and lemurs, and on this account these animals have been regarded as near relatives of the Primates But pectoral mammae are found also in the Sirenia (manatee, dugong), which live in the sea and differ widely from the primate type From this it follows that the position of the mammae is not a character indicative of affinity, but is to be explained by the necessities of equilibration and of the mode of life of the animal

Again, there is to be found in the Dinosauria, Crocodilia, Aves and Echidna, a perforation of the bottom of the cotyloid cavity in which the femur is articulated, and this has been taken as evidence that all these beings are descended from a common stock But the perforation is to be explained by the conditions governing the formation and functioning of the bones that circumscribe this cavity, and consequently it is devoid of any atavistic or ancestral significance In any case, even if these groups were descended from a common stock, it is most unlikely that, while diverging from it so widely in other respects, they would not have diverged from it at all in this particular

In his detailed study of the man of La Chapelle-aux-Saints, Boule compared the relative measurements of the skull with those of the skulls of other men and apes, and drew up a series of indices expressing the ratio of height to breadth, and of height to length Thus he obtained as one series European man, adult gibbon, man of La Chapelle, Ostiak man, chimpanzee, another Ostiak Taking another index, he obtained a series that passed immediately from a marmoset to Gibraltar man (fossil), and later on had a sapajou between a Frenchman and an Eskimo He maintained that these series prove that man and the apes form a single group, descended from one stock It is much more likely that the criteria on which he based this judgement have not the value he assigned to them The relation or proportion that exists between certain cranial measurements is not a character whose connection with inter-specific kinship is self-evident, and Boule did not attempt to show why there should be such a connection He assumed gratuitously that there is a connection, and gratuitous assumptions do not need to be refuted

Extreme Evolutionists, going on superficial resemblances have sometimes affirmed the identity of structures in reality very different from one another, such as the branchial arches

of *Amphioxus* (the lancelet) and those of vertebrates Although the structures have been given the same name, they are quite different In the fish, they are true branchial arches—powerful structures, forming the lateral walls of the head and neck, their skeletal framework, endowed with its own muscles, is correlated with the muscles of the trunk, and so the arches, besides their respiratory function, constitute a part of the muscular-skeletal walls of the body and contribute their share to its movements In *Amphioxus*, on the other hand, the structures in question are not branchial arches but pharyngeal rods The pharynx is enormous, extending half the length of the body, the fine rods of which it is constructed are infinitely more numerous than the branchial arches of the fish, and their inner constitution and relations with the trunk are altogether different This pharynx plays no part at all in the formation of the body walls—it forms part of the viscera and so is profoundly different from the branchial basketwork of the fishes, to which it has been compared

Again, the pectoral girdle of the monotremes is commonly said to be a reptilian character, because it contains ventral pieces that have a certain resemblance to the procoracoid and coracoid of reptiles The inference is quite invalid, for the pectoral girdle in the monotremes, as in the other mammals, is absolutely outside the thorax In the mammals, the thorax is constituted by the ribs and sternum alone, whereas in reptiles the pectoral girdle, including the coracoid, is a part of the thoracic framework Consequently, the "coracoids" of monotremes, being extra-thoracic, have no connection with the heart and lungs, as have the true coracoids of reptiles, and it is false to say that the pectoral girdle of the monotremes is reptilian in character

Another feature of the monotremes that is often said to be a reptilian character and to prove their affinity with the reptiles is their possession of a "cloaca" The common orifice of the intestinal canal and the uro-genital ducts is designated "cloaca" in the case of both reptiles and monotremes, but once again the resemblance is only superficial—the one name is applied to two cavities that are morphologically quite different In reptiles and birds, the terminal part of the intestinal canal is divided by two valves into three successive compartments The genital and urinary ducts enter through the roof of the middle chamber and the cloaca is the orifice of the last one In the monotremes

on the other hand, there are no successive chambers or compartments, but two ducts, one lying above the other; above is the rectum, which terminates the intestinal canal, and below is the uro-genital sinus, which receives the urinary and genital ducts. Both rectum and sinus terminate very close together in the slight depression of the body that is the "cloaca" It is clear that a cloaca constructed in this way is quite different from that of birds and reptiles

We must not allow ourselves, therefore, to be misled by the word "character," and accept uncritically everything presented as such It is true that certain traits are so constant and so peculiar that in practice they may suffice to mark off one group from another, e g , hair for the mammals, and feathers for the birds, and other less important traits for smaller groups But if these traits are very handy, and often sufficient to enable us to classify beings at once, this does not mean that they reveal to us the true nature of these beings and by themselves constitute a sufficient ground for separating one group from another Sometimes a trait that is obviously unimportant suffices to enable us to divide a family into its genera, e g , the size and shape of the scales on the paws

The determination of characters calls for a complete knowledge of the parts of the different organisms that are compared and a comprehension of the significance of these parts Too often structures are designated by a single name, because of a superficial resemblance that covers a deep dissimilarity [104]

Homology Naturalists distinguish between homology and analogy homology is basic, structural similarity, while analogy is superficial, functional similarity Organisms are said to be homologous when, beneath a certain amount of external diversity, they possess in common a group of correlated internal resemblances of such a nature that the organisms possessing them appear to be constructed on the same fundamental plan Similarly, the organs of different animals are said to be homologous when they are composed of like parts, arranged in a similar relation to one another Homologous organs correspond, bone for bone, tissue for tissue. so that each component of the one finds its counterpart in the other For example, despite wide differences

[104] Material on characters taken from Vialleton, L'Origine des Etres Vivants, pp 86-91

in function and outward appearance, the wing of a bat, the flipper of a whale, the foreleg of a cat, and the arm of a man all embody the same basic plan, being composed of bones—shoulder-blade, humerus, ulna, radius, hand—similarly disposed with respect to one another The wing of a bird and the wing of an insect, on the other hand, despite their similarity of function, are fundamentally unlike in structure, they are not homologous, but analogous

The word "homology" was introduced by Owen in 1845, although the existence of homologies had been established earlier by E. G St Hilaire and Cuvier For Cuvier, the fact of homology was merely the external manifestation of the laws governing the beings in which homologies were found—beings of a similar nature would be organized according to similar laws and so would resemble one another in their basic structure

Extreme Evolutionists interpret the fact of homology in a different way—for them these structural similarities are evidence that the beings possessing them are descended from a common ancestor They hold that in the two diverse types there remains a basis or foundation handed down from a common stock, together with a superficial dissimilarity due to variation or divergence Thus Darwin wrote "What can be more curious than that the hand of a man, formed for grasping, that of a mole for digging, the leg of a horse, the paddle of a porpoise, and the wing of a bat, should all be constructed on the same pattern, and should include similar bones, in the same relative position? Geoffroy St Hilaire has strongly insisted on the high importance of relative position and connexion in homologous parts, they may differ to almost any extent in form and size, and yet remain connected together in the same invariable order We never find, for instance, the bones of the arm or fore-arm, or of the thigh and leg, transposed Hence the same names can be given to the homologous bones in widely different animals Nothing can be more hopeless than to attempt to explain this similarity of pattern in members of the same class, by utility or by the doctrine of final causes The hopelessness of the attempt has been expressly admitted by Owen in his most interesting work on the 'Nature of Limbs' On the ordinary view of the independent creation of each being we can only say that so it is,—that it has pleased the Creator to construct all the

animals and plants, in each class, on a uniform plan, but this is not a scientific explanation.

"The explanation is to a large extent simple on the theory of the selection of slight modifications,—each modification being profitable in some way to the modified form, but often affecting by correlation other parts of the organization In changes of this nature, there will be little or no tendency to alter the original pattern, or to transpose the parts The bones of a limb might be shortened and flattened to any extent, becoming at the same time enveloped in thick membrane, so as to serve as a fin, or a webbed hand might have all its bones, or certain bones, lengthened to any extent, with the membrane connecting them increased, so as to serve as a wing, yet all these modifications would not tend to alter the framework of the bones or the relative connection of the parts If we suppose that an early progenitor—an archetype, as it may be called—of all mammals, birds, and reptiles, had its limbs constructed on the existing general pattern, for whatever purpose they served, we can at once perceive the plain signification of the homologous construction of the limbs within the class"[105]

Although this argument of Darwin's is fallacious on several counts, as we shall show, it is safe to say that it has done more than any other to convince people of the truth of the theory of Extreme Evolutionism For its dialectical effectiveness there are two main reasons. In the first place, it offers a positive explanation, along scientific and non-philosophical lines, of the fact of homology On the other hand, those who reject this explanation cannot provide another that is equally easy to understand They may content themselves with a philosophical explanation and admit their inability to find a scientific one, affirming that the homologous structures are similar because God made them so, to manifest His power and wisdom As a musical composer reveals his skill in writing variations on a single theme, so God would manifest His power by constructing a great variety of organs according to the same fundamental plan In these days, when so many hold the Positivist creed that scientific knowledge is the only valid form of knowledge, to suggest that a certain fact has no scientific explanation but may be explained in terms of philosophy is to invite ridicule

[105]The Origin of Species, pp 358-360

Accordingly, some of those who reject Darwin's explanation of homology attempt to give an alternative scientific explanation, alleging, for example, that in those vertebrates in which the fore-limb is homologous, the structure most effective for the various purposes for which the forelimb is used is the structure we actually find—humerus, ulna and radius, hand It is not easy to show, however, that this is actually the case Darwin's explanation is simpler, and therefore more acceptable, and at first sight it seems a reasonable interpretation of the facts. If we notice a remarkable resemblance between two boys, the first explanation that occurs to us is that they are brothers, and Darwin's explanation of homology is based on the same principle

Secondly, the Darwinian explanation can be presented in a manner that gives it a strong imaginative appeal When a class, for example, is shown a series of skeletons, carefully arranged so that the more complex follows the less complex, in such a way that one may pass from man down to the lowest vertebrate, and the instructor points out the homologies, it is morally certain that the class will accept without demur the conclusion that the higher types have sprung from the lower, and all from a common ancestor, "the unknown progenitor of the Vertebrata,"[100] as Darwin calls it How many would pause to ask whether the arrangement of the skeletons was justified—whether, for example, each was, palaeontologically, in its right place? How many would appreciate the anatomical difficulties implied in the transition from one form to another, e g, from fish to amphibian How many would suspect that the direct evidence for the existence of any progenitor of all the Vertebrata is nil? How many would understand that an animal that is simply a vertebrate, and not some special kind of vertebrate, is a figment of the imagination, which could not be translated into concrete reality? Would there be even one? All would have been so won by the imaginative appeal of the argument that the questions a critical mind would ask would not even have presented themselves to their minds. And convictions thus formed do not yield readily to argument

However, the worth of an argument is not to be gauged by its capacity to satisfy our desire for simple explanations nor

[100]The Origin of Species, p 361

by its appeal to the imagination, but by the soundness of the principle on which it is based.

Darwin's argument from homology rests on the principle that the structural similarity of two organisms indicates that they are descended from a common ancestor "Community of descent," Darwin wrote, is "the one known cause of close similarity in organic beings"[107] This principle is unsound, and has, in fact, been abandoned by the Darwinians themselves Close similarity of structure may in certain cases be due to community of descent, but, as all admit, there are innumerable instances where it is not Berg has drawn attention, for example, to the striking structural similarity, extending to the minutest details, between the spermatozoon of the toad *Bombinator igneus* and the flagellate *Trichomonas angusta,* two forms which certainly do not owe their similarity to community of descent Other examples are the claws (*chelae*) of scorpions, crustacea, and the bug *Carcinocoris,* the telescopic eyes with supplementary retina found in deep-sea fishes and certain crustacea and insects, the divided eye (one part being used for surface and the other for underwater vision) in the fish *Anableps tetrophthalmus* and the whirligig beetles *Gyrinidae,* the complex eyes of cephalopod molluscs and vertebrates, which agree in having retina, iris, cornea, ciliary process, and (in some cephalopods) eyelids, in the bugs *Polyctenidae* and the flies *Streblidae,* the head is divided into two parts, one a terminal, crescent-shaped, movable section, the other a basal section, the two parts being joined by an articulation[108] The evolutionary explanation of such resemblances is "convergence"—the tendency of organisms living in similar surroundings to vary in a similar manner Darwin regarded convergence as an exceptional phenomenon, but in reality, as Berg has shown, "what in the opinion of the adherents of selection is exceptional is really the rule"[109] Now if we inquire how we are to distinguish between homologies due to community of descent and those due to convergence, the exponents of Extreme Evolutionism can give us no objective criterion Gegenbaur says that the study of genealogical relations will enable us to discriminate between the two, but this involves a *petitio principii,* for the genealogical relations are established

[107] The Origin of Species, p 342
[108] Cf Berg, Nomogenesis, pp 156-234, for further examples
[109] Ibid, p 156

on the basis of the similarities that are supposed to be due to community of descent Nor can we escape from the vicious circle by referring to the data of palaeontology, for, as we have seen, palaeontology knows nothing of common ancestors of the great groups, such as the mammalian orders, nor of any intermediate forms linking one order with another Consequently, all the homologies could be due to convergence, leaving none to be accounted for by descent from a common ancestor

Julian Huxley has admitted that the "natural classification" at which post-Darwinian biology has aimed—that is, the classification based on the genealogical interpretation of homology—is unsatisfactory, because "it assumes—what we now perceive to be erroneous—that the only natural method of classification is one based on naive and pre-Mendelian ideas of relationship taken over from human genealogy and applied to groups instead of to individuals"[110] Later in the same work he says "The interminable disputes of morphologists brought up in the post-Darwinian school, determined to discover precise correspondence between individual bones, and to draw phylogenetic conclusions from their homologies, turn out to have no factual basis,"[111] because evolution may have caused some of these bones to coalesce

To sum up, we reject the interpretation of homology offered by Extreme Evolutionism, because the principle on which it is based is unsound Similarity of structure need not be a sign of descent from a common ancestor A common ancestry will explain the similarity in certain cases, but except within the limits of the species or genus, the Extreme Evolutionist is unable to provide any scientific criterion by which to determine when this is the explanation and when it is not It may not be possible to provide an alternative scientific explanation of homology, but it is better to be ignorant than to be in error

Having dealt with the genealogical interpretation of homology, we have next to consider briefly the evolutionary account of the fact itself Darwin and his followers speak of wings and arms as they would of generic characters of ornamentation or outer covering, such as crests or spines, or the scales of fish or reptiles, which differ all the more widely as these

110Evolution, the Modern Synthesis, p 410
111Ibid, p 544

differences do not affect their functioning, and can be linked to one another by gradual transitions. Gradual divergence from a simple form may be possible in the case of these parts of the organism, but it is impossible to conceive of such a transformation taking place in the case of a structure like the forelimb of mammals or tetrapods. What sort of limbs would an animal have, if they were constructed on the general pattern common to mammals, birds, and reptiles? If a member were not specially constructed to serve as a wing, how could it serve as a wing? Or if it were not constructed to serve as a mammalian forelimb, how would it be able to perform its functions? Still less is it possible to conceive of a limb that would serve as a wing, foreleg, arm, and flipper, by turns In a word, Darwin's "limbs constructed on the existing general pattern" are a chimaera.

Vialleton writes "Strictly speaking, when one considers the bones of the different members spread out on a table in their order of succession, no account being taken of the orientation of the entire member and of its different parts, or of its attachment to its girdle (pectoral or pelvic), or of its mode of functioning, it is possible to pass from one to another by shortening one bone and lengthening another These are mental operations such as we make in all our comparisons, and they allow us to establish ideal connections between things But to assert that beings which it is so easy to link in thought have been derived from one another by gradual changes wrought during life, is an entirely different matter The detailed study of the limbs, of their orientation, and of their functioning, shows the absolute impossibility of these gradual transitions, because each distinct type of limb (paw for grasping, paw for walking, flipper, wing), although constructed fundamentally of the same skeletal materials, is, by the arrangement and proportion of these materials, a special machine, which cannot transform itself into another in the course of its functioning An internal combustion engine and a steam engine are constructed along fundamentally the same lines, but it is impossible to make an engine that is midway between them, each one from the moment that it exists possesses its own proper proportions and rhythm "[112]

[112]L'Origine des Etres Vivants, p 94

To illustrate the impossibility of such a gradual transformation, we may take the evolutionary hypothesis that the whale has been formed by a process of gradual change from some terrestrial mammal The terrestrial mammal propels itself by the action of its four limbs, whereas the whale propels itself by the vertical motion of its tail Each form of locomotion entails a great number of skeletal and muscular correlations that are necessary if the animal is to survive Many of these correlations are mutually exclusive, so that if a terrestrial mammal were to be gradually transformed into a whale, the animal would in the intermediate stages lack some of these correlations and so could not survive It is not surprising, then, that no evolutionist has been able to provide even an approximate account of the anatomy of such an intermediate form

Correlations Since every organism is composed of parts that co-operate for the good of the whole organism, there will necessarily exist, between the various parts and the whole, relations of position, size, and reciprocal action, and it is these relations that are called correlations Although the existence of correlations had not escaped the notice of the ancients, it was Cuvier who first made a profound study of the matter and conclusively established their existence "Every organized being," he wrote, "forms a whole, a single closed system, whose parts mutually correspond and concur by their reciprocal action in the production of a single result No part can change without the others changing with it If the intestines of an animal are organized so as to digest only flesh meat, it is necessary that its jaws be constructed for the devouring of prey, its claws to seize and tear it, its teeth to cut and divide it, the whole system of its organs of movement to pursue it and catch it, etc"[113]

By applying this principle, Cuvier was able to reconstruct many vertebrates now extinct, of which only fossil fragments remained, and although he made a few mistakes, he achieved wonderful success, having his reconstructions for the most part confirmed by later discoveries At times palaeontologists have criticized the principle, and certainly it has sometimes been taken too far, as if a whole animal could be reconstructed from a single tooth Nevertheless, the principle is sound, and the

[113] Quoted in Vialleton, op cit, p 114

palaeontologist must use it as the only means he has of understanding his discoveries, for to understand a limb or other skeletal part, he must see it as part of a complete skeleton, if mistakes are made, it is not because the principle is wrong, but through the inadequacy or incorrect interpretation of the evidence

Cuvier, confining his attention to anatomy, was concerned mainly with the correlations between the large parts of the organism Since his day, correlations have been established in terms of histology, the science of cell-structure, but nothing essential has been added to his conception of the matter

Correlations can be divided into two classes—architectural correlations, based on a study of the animal as a whole, and local correlations, based on the study of some part Local correlations are easier to perceive, but it is the architectural correlations that have to be considered if one is to understand the nature of the organism An example of local correlation is that of the temporo-mandibular articulation with the mode of life of the animal to which it belongs An architectural correlation would be the arrangement of the skeleton, muscles and viscera that ensures the locomotion of the animal and its equilibrium in air or water.

From this it is clear that correlation is not mere coincidence, however constant, and that Darwin was mistaken when he quoted the fact that white cats with blue eyes are usually deaf as an example of correlation [114] The true idea of correlation implies the reality of final causes, and consequently it cannot be reconciled with Darwinian principles It is not surprising, then, that Darwin neglected correlations and insisted almost exclusively on homologies Rabaud declared that correlations do not exist —the adaptation of structure to structure within the organism would be mere coincidence As Vialleton remarked, no mechanic who has built engines to move in air or water, would be able to follow Rabaud's reasoning Rabaud urged that nature sometimes supplies the animal with more than is strictly necessary, but it is obvious that this fact proves nothing against the existence of correlations.

Correlations, as Cuvier understood the term, are extremely comprehensive, extending to all the tissues and organs of the

[114] The Origin of Species, p. 8

living thing, although it is often not possible to discern their exact relation to one another and to the good of the whole organism. However, they are numerous enough to make the distinction between the great groups, such as the classes, quite clear The platypus is sometimes represented as a form intermediate between the mammals and the reptiles A study of the correlations of the platypus, however, reveals that it is completely mammalian in character Although the brain of the platypus is immeasurably inferior to man's, both man and platypus have the same hairy skin, with the same epidermis provided with a granular layer and dermis provided with papillae, both have the same red corpuscles without nucleus, the same kind of conjunctive and bony tissue, the same kind of thorax with the exclusively mammalian diaphragm The reptile, on the other hand, is quite different its skin is without hair, the epidermis has no granular tissue, the dermis is devoid of papillae, the bony tissue is different, etc The platypus, it is true, lays eggs, like some reptiles, but this oviparity is of little account, when compared with the profound differences between the mammalian and the reptilian type Among some closely allied snakes, certain species are oviparous, while others are viviparous

The fact of correlation, as we have pointed out in the case of the whale, precludes the possibility of one type being gradually transformed into another The essential features of a type cannot be acquired one by one, whether by chance variations or the use and disuse of particular organs, but all must be present together if the organism is to live Berg, after pointing out how the Dipnoi (lung-fishes) and the amphibians certainly arose independently of each other, dwelt on the impossibility of accounting for the origin of such types by the Darwinian factors of evolution "It seems incredible," he wrote, "that in the Dipnoi and in the ancestors of the Amphibia chance characters arose, which enabled both to transform a branchial into a pulmonary respiration such a transformation would require a simultaneous modification not of one but of a number of systems, including the heart, the vessels, the nasal cavity, the lungs, the muscles, etc That all this should have been combined into one harmonious whole by means of accidental variations of characters, and that such a consummation should have been effected simultaneously in the two groups, the Dipnoi and the ancestors

of the Amphibia, is a miracle which no naturalist ought to credit."[115]

A phenomenon similar to correlation and equally impossible to explain as the result of gradual evolutionary development is that of mutual adaptation, i e , the existence in separate individuals of adaptations that are complementary An obvious example is that of the reproductive organs in beings whose generation is sexual Such an adaptation must be perfect from the beginning if the type is to survive, it cannot be acquired gradually, and still less can it be the product of chance variations Another example is provided by the mammalian method of nourishing the young. If mammals evolved from reptiles or amphibia, both mother and young of the nascent mammal would have had to be pre-adapted, the mother acquiring nipples, while the young acquired soft, muscular lips, organs that are quite unknown in reptiles and amphibia These mutual adaptations are even more numerous in the case of the kangaroo. At birth, the young kangaroo is little more than an inch long, it is blind and incapable of sucking; its fore limbs are considerably longer than the hind, and they are provided with well-developed claws When the youngster emerges from the mother's uro-genital sinus, it climbs with the aid of its clawed forepaws into her pouch. On reaching the teats, it seizes one with its lips The tip of the teat then swells so that it cannot be pulled out of the mouth without the exercise of considerable force Further, there is a sphincter muscle round the mouth of the baby kangaroo to enable it to grip the nipple firmly Although, because of these pre-adaptations, it can grip and hang on to the nipple, it has not sufficient strength to suck, accordingly the mammary gland of the mother is furnished with muscles that force the milk into the gullet of the young one. In order that none of the milk so injected shall enter the windpipe and the youngster may breathe while it is being fed, its windpipe is prolonged upwards and forwards to fit into the back of the nasal tunnel To prevent milk escaping by the sides of the mouth, these are closed, and, for a time, the mouth does not enlarge with the growth of the rest of the body None of these pre-adaptations would be of any use apart from the others or until all were well developed, they form a close-knit pattern, of which all the parts must be present

[115]Nomogenesis, p 174

if the species is to survive Since the pattern must be there with all its parts or not at all, it could not have originated by the natural selection of chance individual variations, nor by the use or disuse of certain organs, but must have begun to exist in all its complexity as the result of some process of instantaneous change

Vestigial Organs Darwin attached considerable importance to the existence in man of so-called "vestigial," or "rudimentary," organs, which he regarded as valuable evidence of man's descent from the lower forms of life "Organs bearing the plain stamp of inutility," he wrote, "are extremely common, or even general throughout nature It would be impossible to name one of the higher animals in which some part or other is not in a rudimentary condition"[110] He argued that most parts and organs are exquisitely adapted for certain functions, whereas these are atrophied and functionless or almost functionless The only reasonable explanation is that in former times such organs were well developed and useful to their possessor, which belonged to a lower form of life, but have ceased to be of use to the higher form in its new conditions, and have atrophied and ceased to function

We have to consider here whether vestigial organs are as common as Darwin asserted them to be, and what light the existence of such organs, if they do exist, would throw on the present diversity of organic forms

There does not seem to be any inherent impossibility in organs atrophying through disuse and becoming vestigial Thus, a type could possess certain organs in a state of high development at the beginning of its career, and afterwards through changing conditions cease to derive any benefit from these organs, which would then degenerate It is not by any means certain, however, that disuse does cause an inheritable degeneration of any organ, the Lamarckians assert that it does, but the experimental evidence they bring forward is not convincing, and a great many biologists reject their view

The next difficulty is to determine what organs are devoid of function, and thereby candidates for admission into the category of "vestigial organs." As history has shown, it is hazardous to assert that an organ is functionless and therefore

[110]The Origin of Species, p 372

vestigial or rudimentary, just because we do not know of any function that it fulfils There is a good deal of truth in the saying that the only thing that is rudimentary is our knowledge For example, the pineal, pituitary, and thyroid glands were at one time classed as rudimentary organs, but subsequent investigation showed that these glands exercise functions of great importance for the well-being of the animal

A number of organs are still frequently referred to as vestigial, even though it is known that they perform some function Such are the ear muscles in man, which serve to extend and fix the epicranial aponeurosis, human hair and its muscles, which serve to promote the distribution of an oily fluid required to keep the skin in good condition, the semilunar fold in the human eye, which serves to regulate the flow of tears, the vermiform appendix in man, which contains glands that secrete an intestinal lubricant; the os coccyx in man, which serves for the attachment of several small muscles that could not function without it and also protects the rectum

In this connection it should be noted that an organ is not shown to be vestigial by the fact that it can be removed with impunity, all that this shows is that its functions are either not essential, or, if essential, can be performed in an emergency by some other organ

We must also remove from the list of vestigial organs embryonic outlines and remains, which are of use to the individual in its embryonic state, even though they do not exist or are devoid of function in the adult Such, for example, are the "branchial" arches in amniotes (reptiles, birds, mammals), which show no signs of disappearing, and are not the reduced forms of gills, but the beginnings of quite different organs The teeth in the embryos of certain whales and ruminants that never pierce the gum in the adult are not vestigial, because they play an important part in the formation of the jawbone of these animals, furnishing resting points on which it models itself The mammae in the males of mammalia are not, as Darwin held, vestigial, since they do not represent the atrophied state of an organ that once had a function, but they are embryonic rudiments The same applies to the so-called vestigial hind-limb found in certain whales, which is really an embryonic remnant, left over

from the construction of the pelvic girdle and does not bear witness to a long regressive development

Finally, it is to be noted that even if vestigial organs do exist, they will furnish evidence only of degenerative evolution To establish the reality of progressive evolution—and this is the aim of the various forms of Extreme Evolutionism—examples of nascent organs are required, that is, organs in the process of evolution from a less perfect form Darwin suggested (not very hopefully) the wing of the penguin and the mammary glands of the platypus as examples of nascent organs, but these have since been rejected, and no others have been put forward to fill the gap This is a serious flaw in the evolutionary interpretation of this section of comparative anatomy, an interpretation that, as we have seen, is already beset by serious difficulties in its chosen domain of vestigial organs

EMBRYOLOGY

In the course of their development from the fertilized ovum, the higher forms of life pass through many intermediate stages, so that their structure becomes progressively more complex until the adult form is reached K E von Baer (1792-1876), the founder of embryology, expressed these facts in four laws, which may be summarized as follows 1 The most general features of a great group appear earlier in the embryo than do the special features 2 Out of the most general structures the less general structures arise, and so on, until the most special structures appear 3 During its development, an animal departs more and more from the form of other animals 4 The young stages in the development of an animal are not like the adult stages of other animals lower down in the scale, but are like the young stages of those animals

The idea that the higher forms of life, in the course of their development, really pass through the stages of organization proper to the adult stages of lower forms was put forward by E G St Hilaire and F Muller, but it was Haeckel who exploited this idea to the full in favour of Extreme Evolutionism Haeckel went so far as to assert that the fundamental law of biogenesis is that "Ontogeny is a short recapitulation of phylogeny," i e, the development of the individual repeats in a summary way the evolution of the race He explained in this sense the first three laws of Von Baer (omitting to mention the fourth), and argued

that the facts of embryology show that the higher forms of life have arisen by evolution from the lower Embryology, says Milnes Marshall, paraphrasing Haeckel, reveals that "every animal climbs up its own family tree"[117] Haeckel's "Law of Recapitulation," as it was called, was for long accepted with uncritical credulity by great numbers of scientists "Biologists," wrote Radl, "were led into error by the impassioned way in which Haeckel affirmed the truth of his theory . they set to work to collect facts which were to prove the truth of his biogenetic law"[118] It was found, however, that the facts did not agree with the "law," and Haeckel, who had at first propounded the "law" without any qualifications, was compelled to introduce various modifications, such as "caenogenesis," i e, the falsification of the ancestral record by the introduction into embryonic development of stages to which there is nothing corresponding in phylogeny Another device to save the "law" was the idea that in the development of the individual there are short-cuts, so that many intermediate stages of the phylogeny are not represented in ontogeny Nevertheless, undaunted by the difficulty of interpreting objectively facts governed by so flexible a "law," Haeckel traced about thirty stages in the development of the human embryo He affirmed that each stage represented a different lower form of life, although only a few of these were identical with forms of life known to have actually existed This Haeckelian pedigree of man, Du Bois-Reymond remarked, is worth about as much as the pedigree of Homer's heroes Such ambitious attempts have been abandoned, and the "law" itself is now commonly rejected The damage done to biological inquiry by the "law" has been considerable "The prestige so long enjoyed by the theory of recapitulation," de Beer declares, "has had a great, and, while it lasted, regrettable influence on the course of embryology"[119]

Although the Haeckelian interpretation of ontogeny has been abandoned by the majority of biologists, we cannot dismiss it without further discussion, because it has been upheld fairly recently by J B S Haldane and others, and still appears in popular presentations of Extreme Evolutionism We shall there-

[117]Lectures on the Darwinian Theory, Nutt, London, 1894, p 84
[118]The History of Biological Theories, p 138
[119]Embryos and Ancestors, Oxford U P, London, 1940, p 9

fore show that Haeckel's "law" is not a law at all, but a fanciful hypothesis, based on a gross misinterpretation of the facts of embryology

It is not a general law, for, as all admit, it does not apply to plants If recapitulation be a law of nature, it is inexplicable that plants should not be subject to it, for in the hypothesis of Extreme Evolutionism, plants and animals are descended from a common ancestor

Nor can it be called a particular law, applying only to the animal kingdom, for a law has not to be bolstered up with *ad hoc* hypotheses such as those with which Haeckel attempted to save his "law" Haeckel simply proclaimed his theory a "law," and then dealt with inconvenient facts by arbitrary theories like "caenogenesis"

Next, the "law" is based on a misinterpretation of the facts of embryology In all its stages of development, the embryo is quite different from any complete form of life, any being similar to the embryo at any one of its stages could not live independently As Von Baer pointed out, what similarity there is is between embryos, and this similarity is due to the fact that in the embryo there are only the rough outlines of organs, so that in types that have the same basic organization these outlines will resemble one another This embryonic similarity is a particular instance of homology, and when used as an argument for Extreme Evolutionism is covered by what has been said already concerning the argument from homology In Haeckel's mind, the facts of embryology provided an argument for evolution quite distinct from the argument based on homology, and it is this embryological argument that concerns us here

To understand the process of ontogeny, it is not the hypothetical ancestors of the animal being formed that have to be considered, but the final structure that is to result from the fertilized ovum "Ontogeny," wrote Berg, quoting Von Baer, "is not a repetition of the past, but a preparation for future stages by the aid of preceding ones It is the highest embodiment of the principle of development in a definite direction, i e, of development determined by law"[120] Or, to quote Vialleton, "when all the facts have been carefully studied and analysed, embryonic development is seen to be the result of an intelligent

[120]Nomogenesis, p 133

action which, taking account of the principle of economy and of the necessity of passing in every mechanical development from simple to complex, from general to particular, makes an infinity of diverse forms, starting with a relatively simple model"[121]

Furthermore, Haeckel's "law" is refuted by the fact that every embryo assumes at an early stage certain distinctive features of the genus to which it belongs "A careful observer," Driesch declared, "may even attribute a cell of a blastula to a particular species."[122] This may be an exaggeration, but it is certain, nevertheless, that the species of the embryo can often be determined before the embryo possesses any of the features later used to distinguish it, e.g, teeth or claws, simply from the relative proportions of the parts, this is the case for man, the cat, the dog, the lamb, etc At 45 days the human embryo is unmistakably human, and according to Sir Arthur Keith, the expert can distinguish it at 30 days The early appearance of the specific form, discernible when the future skeleton and muscles are rudimentary, is important, for it shows that the organism does not pass through a series of specific forms before assuming that of its parents, but has the same form as its parents very early, and, to all appearances, from the beginning There is every reason to suppose that the fertilized ovum has the same specific form as its parents and that it no more changes its species during embryonic development than when it is passing through infancy and adolescence

The various facts quoted as exemplifying the Haeckelian "law" are cases either of embryological homology comparable in every way to adult homology or of non-homologous similarity arising from the adaptation of the embryo to the necessities of its mode of life

The mammalian embryo, for example, is said to possess gill-slits at one stage of its development, thereby giving evidence of its descent from a fish-like ancestor, furthermore, besides the gill-slits, the embryonic heart, kidneys, and backbone, are also supposed to be distinctively fish-like

In the embryo of the fish, six visceral arches are formed, with clefts between them, these arches are rightly called branchial

[121] L'Origine des Etres Vivants, p 161

[122] The Science and Philosophy of the Organism, 2nd Edn, Black, London, 1929, p 160

or gill arches, because at a certain stage of development the membranes forming the bottoms of the furrows between the arches become absorbed and thus complete clefts are formed These are narrow at first, but gradually broaden Meanwhile, gills grow on the arches, and the blood-vessel in each arch divides longitudinally into two vessels, one of which is connected with the main ventral blood vessel, and the other with the main dorsal blood-vessel The two parallel vessels thus formed in each arch communicate by means of a network of tiny blood-vessels that extend into the gills By this arrangement, the blood that comes from the heart in a venous or impure condition flows into the gills, where it is aerated, passing from the gills to the dorsal blood-vessel, and thence to the various parts of the body

In the embryo of an amniote (reptile, bird, or mammal), no clefts form between the six visceral arches, nor do the blood-vessels in the arches divide longitudinally In these creatures, therefore, neither these arches nor the blood-vessels they contain assume any of the characteristics of gills "The gill-pouches of embryo reptiles, birds and mammals," writes de Beer, "do *not* resemble the gill-slits of the adult fish Anyone who can see can convince himself of the truth of this"[123] In referring to these structures as "gill-pouches," de Beer employs the conventional terminology In another place, he gives them their correct name, at the same time pointing out that they are in no sense vestigial organs "The fact that the pharyngeal pouches of an amniote embryo will never become gill-slits," he writes, "is no evidence that these pouches are useless On the contrary, they play an essential part in providing the rudiments of a host of structures, e g , tympanic cavity, tonsils, thymus and the parathyroid glands"[124]

The similarity of the heart, kidneys, and backbone of the amniote embryo to the heart, kidneys, and backbone of the fish is accounted for by the necessities of embryonic life The embryo needs a heart and kidneys early in its development, and as it would take too long to construct the complex heart and kidneys of the adult form, simpler structures, which resemble the simple heart and kidneys of fish, are constructed The complex adult heart is afterwards formed out of the embryonic structure, but

[123]Embryos and Ancestors, p 38
[124]Ibid , p 91

the embryonic kidneys (of which there are two successive forms) are not used in the construction of the adult kidney. The cartilaginous character of the embryonic backbone of the amniote is explained by the necessity of having a tissue that can grow rapidly and does not require the presence of the numerous small blood-vessels that are essential for the development of bone

It is clear, therefore, that there is no justification for the statement that the amniote embryo passes through a fish-like stage in the course of its development, and still less for the statement, still sometimes made, that these so-called fish-like structures have no function or utility. Embryonic development provides us with many instances of homology, but homology, as we have seen, far from being a proof of Extreme Evolutionism, can be explained in Cuvierian terms—as evidence of an Intelligent Designer who has constructed various kinds of organisms according to the same basic plan

GENETICS

Genetics, a branch of physiology, is the science that studies heredity, endeavouring to discover the causes that make the offspring in some respects similar to, and in other respects different from, its parents Since evolution consists in the progressive divergence of offspring from an ancestral type, it is clear that any causal theory of evolution will make considerable use of the findings of genetics

It should be noted, however, that the scope of genetics as an experimental science is severely limited In the first place, the fact of heredity itself is not capable of explanation on the scientific level The power of reproduction, of which heredity is an aspect, is a primordial property of life, and is no more capable of scientific explanation than life itself "All organisms," wrote Driesch, "are endowed with the faculty of creating their own initial form of existence."[125] This is an ultimate datum for the geneticist, who has not to explain why living things possess this power or how they came to possess it, but only how it works Genetics subjects the process of heredity to analysis in order to determine the individual factors involved in it, but it can provide no explanation of the process as a whole That falls within the province of natural philosophy "Genetics," J B S

[125]The Science and Philosophy of the Organism, p. 142

Haldane declared, "can give us an explanation of why two fairly similar organisms, say a black and a white cat, are different It can give us much less information as to why they are alike"[120] The truth is, as we have just said, that on this second point, it can give us no information at all

Secondly, since genetics discovers the factors responsible for the variation of individual characters by crossing organisms of the same type, it can work only with organisms whose manner of reproduction is sexual, and only within the range of a species, or at most a genus Consequently, while it may be able to throw some light on the origin of new races and species, it has nothing to say about the origin of the higher categories—families, orders, classes and phyla, and, of course, it is the origin of these higher categories that is the main problem The geneticist may indeed assert that the causes that account for variation within the species account for all the variation in the animal kingdom, but if he asserts this, he is going far beyond his facts and indulging in mere speculation

Within these narrow limits, genetics has made great advances in the past hundred years, especially since the re-discovery at the end of the last century of the findings of Mendel, which had been published in 1865 Mendel's laws point to the conclusion that the germinal material contains a number of factors that remain the same from generation to generation These factors have been called "genes" The offspring receives a set of genes from each parent, and the genes that the parent hands on depend in turn on those it has received from its parents A character in the offspring, e g, its colour, may be determined by both parental genes or only one, in the latter case, the active gene is said to be "dominant" and the inactive one "recessive", but recessive and dominant genes are equally transmitted by heredity

From time to time offspring arise that possess some character noticeably different from those previously possessed by the stock, and capable of being transmitted by heredity These are mutants and the change producing the new character is a mutation

On this foundation many biologists erected an atomistic theory of heredity, treating the genes as units of heredity and independent entities, each one being a particle located in a

[120]The Causes of Evolution, p 61

chromosome of the cell-nucleus, and the germ-cell as nothing more than an aggregate of genes. By the slow accumulation of mutations of single genes, and the preservation of favourable mutations by natural selection, the germinal material would eventually be so different from the original stock that crossing would be impossible and thus we should have a new species This neo-Darwinian theory, held by such men as J B S. Haldane, Julian Huxley, Dobzhansky and White, is not really a scientific theory, but "a derivative from a mechanistic philosophy and has no other justification"[127] In the mechanistic philosophy, all phenomena, including vital phenomena, are explained as the outcome of the motion of material particles, consequently, in this philosophy, the phenomena of inheritance will be attributed to the inter-action of an aggregate of material particles, the genes However, even those who still hold the theory are coming to admit that it is no longer tenable Thus White writes "The newer conception of the chromosome as an organized body whose parts stand in a functional relationship to one another has replaced the crude and atomistic idea of a row of entirely independent chromomeres like beads on a thread."[128] The genes, says Julian Huxley, are "delicately adjusted to one another so as to produce a harmoniously functioning whole"[129] Whatever the genes may be in themselves (a matter on which no one can provide any factual information), they exercise a subordinate function in the germ-cell, being subject to some co-ordinating, unifying principle The existence and nature of this principle, the substantial form or "entelechy," are discussed in natural philosophy "If now," wrote Driesch, "we introduce the modern name of 'genes' for the ultimate material units transported in propagation from one generation to the next, we are entitled to say that inheritance has as its material basis the uniting and splitting of genes But the genes, as material entities of whatever kind, cannot, by themselves, account for inheritance In the first place, their community is most decidedly an aggregate

Entelechy and genes are working together Entelechy uses the genes as its means and all order in morphogenesis is exclusively due to entelechy"[130] This is true, with the reserva-

[127]Russell, The Interpretation of Development and Heredity, p 160
[128]Animal Cytology and Evolution, Cambridge U P, 1945, p 152
[129]Evolution, the Modern Synthesis, p 85
[130]The Science and Philosophy of the Organism, p 154

tion that entelechy is not to be regarded as distinct from, but as embodied in the germ-cell, so that it is the germ-cell that uses the genes, as a man uses his hand In a word, the unit of heredity is not the gene, nor the chromosome, nor the nucleus, but the whole germ-cell

In his book, *The Material Basis of Evolution,* R Goldschmidt declares that "the neo-Darwinian theory of the geneticists is no longer tenable"[131] He challenges the neo-Darwinians "to try to explain the evolution of the following features by accumulation and selection of small mutations hair in mammals, feathers in birds, segmentation in arthropods and vertebrates, the transformation of the gill arches in phylogeny, including the aortic arches, muscles, nerves, etc , further, teeth, shells of mollusks, ectoskeletons, compound eyes, blood circulation, alternation of generations, statocysts, ambulacral system of echinoderms, pedicellaria of the same, cnidocysts, poison apparatus of snakes, whalebone, and, finally, primary chemical differences like hemoglobin vs hemocyanin, etc"[132] His own contention is that small mutations may explain micro-evolution, that is, evolution within the species, but cannot account for macro-evolution, or the evolution of species and the higher categories He writes "Micro-evolution by accumulation of micro-mutations—we may say also neo-Darwinian evolution—is a process which leads to diversification strictly within the species, usually, if not exclusively, for the sake of adaptation of the species to specific conditions within the area which it is able to occupy This is the case for micro-evolution on the subspecific level of formation of geographical races or ecotypes Below this level, micro-evolution has even less significance (local mutants, polymorphism, etc) Subspecies are actually therefore neither incipient species nor models for the origin of species The decisive step in evolution, the first step towards macro-evolution, the step from one species to another, requires another evolutionary method than that of sheer accumulation of mutations"[133] The formation of a new species is due, he holds, to a complete change of the primary pattern or reaction system, a complicated change of intra-chromosomal pattern, which may

[131]Op cit, p 397
[132]Ibid, p 7
[133]Ibid, p 183

occur instantaneously or in a few steps The germ-cell, he contends, is not a complexus of genes, but a unit, it develops as a unit, and if it is subject to a mutation sufficient to change its species, this mutation does not affect an individual gene or genes, but the whole pattern of the cell. "The idea of the reaction system in the sense in which this term will be used is opposed," he writes, "to the idea of integrated genic action It means that the germ plasm as a whole, i.e, predominantly the chromosome complex, controls the general features of development which lead to a definite type, the species in question This idea dispenses completely with the individual gene and its individual action, with the attending difficulty of integrating mosaic action into a unified whole It considers only a single unit action of the whole germ plasm, with more or less independent action of the individual chromosomes Whether the intricate pattern of this germ plasm is a pattern of genes or whether there are no genes at all, is another problem, the point here is that the germ plasm as a whole controls a definite reaction system, which, then, is not a mosaic of separate effects, but a single developmental system controlled as a whole by one agency"[131]

In rejecting the classical atomistic theory of the gene, Goldschmidt makes a big advance towards the truth, for as we have said, heredity is intelligible only if the germ-cell is regarded as a single unit His criticism of the neo-Darwinian theory of evolution by the accumulation of small mutations is cogent, but the evidence he offers in support of his own theory is largely speculative He assumes that monophyletic evolution is a fact, and then argues, quite correctly, that the immense changes involved in such a process of evolution must have been effected instantaneously or in a few steps He quotes a number of facts to show that a single change affecting the developmental processes can produce a change of an order of magnitude that would be macro-evolutionary if the organism reached maturity, but he does not bring forward any facts to prove that new species have actually come into existence by such a sudden mutation, and still less does he prove that new orders or classes have originated in this way Furthermore, he is so opposed to the introduction

[134]The Material Basis of Evolution, p 218

of what he calls "metaphysical" or "mystical" factors into the explanation of either morphogenesis or evolution, that it seems he would attribute such phenomena ultimately to chance. Thus, he seems to agree with Schindewolf that "the first bird hatched from a reptilian egg", but it is clearly impossible that a completely new organic type, possessing all the adaptations required for its new mode of life, should have originated by chance.

The mutations that have actually been observed in such organisms as *Drosophila,* the fruit fly, do not throw much light on the main problem that concerns us—the origin of the higher systematic categories. First, to quote Dobzhansky, "mutants are on the whole rare, and moreover they arise mostly as single individuals among masses of unchanged representatives of a strain."[135] Secondly, these mutations will often disappear for lack of offspring to perpetuate them. "With mutation rates that are as low as those observed for most genes in the laboratory," Dobzhansky writes, "the number of mutants produced in each generation would be so small that they could hardly find mates."[136] The perpetuation of such mutations is the less likely, because, as all agree, most mutations are harmful. "Taking the evidence all together," writes H. S. Jennings, "the case is strong for the essentially disintegrative nature of the observed gene mutations. It weighs heavily against their constructive or progressive character. It argues strongly against the possibility of explaining by them the adaptive and progressive features of the evolutionary process. The overwhelming majority of mutations, it is clear, are not advantageous. Many of them cause death. Many cause a weakening of the constitution. Many produce obvious defects and abnormalities."[137] Dobzhansky attempts to evade the implications of this fact, declaring that "the classification of mutations into favourable and harmful ones is meaningless if the nature of the environment is not stated."[138] It is true, of course, that some mutations may make an organism ill-adapted to one environment and well-adapted to another, but the fact remains that the majority of mutations are harmful to the organism, whatever be its environment. Thirdly, in such

[135]Genetics and the Origin of Species, p. 29.
[136]Ibid., p. 255.
[137]Genetic Variations in Relation to Evolution, Princeton U.P., 1935, p. 84.
[138]Genetics and the Origin of Species, p. 23.

mutations as have been observed, the fundamental structure of the organism has not been altered In the vast majority of cases, the mutant type remains fully fertile with the parent type A new species, *Primula kewensis,* is said to have been obtained by crossing *P floribunda* and *P verticillata*, the cross, after being propagated by cuttings for several generations, produced seeds that gave plants of the *kewensis* type, fertile with one another and sterile with the original forms Dobzhansky remarks, however, that *P kewensis* is not a strictly true breeding type, since it occasionally throws some aberrant individuals Another example of a new species produced by hybridization is *Raphanobrassica,* which was formed by crossing the radish and the cabbage, and breeds true. However interesting the production of such forms may be, it does not bring us any nearer an understanding of the origin of such organic forms as are represented by the higher systematic categories In hybrids of this kind there is a recombination of the genetic materials provided by the parent stocks, whereas the evolution of one class from another, e g, amphibia from fishes, would imply the production of a large number of completely new structures, well co-ordinated among themselves Julian Huxley admits this when he writes "The formation of many geographically isolated and most genetically isolated species is without any bearing on the main processes of evolution These latter consist in the development of new types endowed with higher all-round biological efficiency"[139] M Caullery writes in the same strain "The facts recorded by genetics do not seem to go beyond the limits of the species or at most the genus They reveal none of the characteristics by which the differentiation of the wider groups—family, order, class—must have been effected"[140] Finally, since the observed mutations seem to be chance phenomena and generally cause only slight changes in the organism, they are quite inadequate as a factual basis for the neo-Darwinian theory that the whole evolutionary process is to be explained by the accumulation of such mutations, such highly specialized forms as the whale and the bat, for example, could not have arisen by the slow accumulation of small chance

[139]Evolution, the Modern Synthesis, p 389
[140]L'Encyclopédie Francaise, Vol IV, part V, sect D L'Hérédité, pp 76-7 ff

variations. "The formation of the great groups on the basis of the evolutionary theory," Caullery writes, "implies an adaptation to the conditions of life, a development of delicate functional apparatuses, that cannot with any probability be attributed to mutations of the kind we know, as if an unlimited series of chance occurrences had sufficed as a rule to create these adaptations."[141]

We may conclude, therefore, that the many facts discovered by genetics in recent years have not brought us any nearer to a solution of the problem of how the principal forms of organic life originated.

BIOGEOGRAPHY

Biogeography is the science that deals with the geographical distribution of the various groups of plants and animals. Darwin devoted two chapters of *The Origin of Species* to a discussion of the facts of biogeography, urging that they are inconsistent with the theory of Fixism and most easily accounted for by his theory of Evolution by Natural Selection. He pointed out, for example, that the faunas and floras of oceanic islands contain few species that resemble the species of the nearest continental mainland, and only such forms of life as could be transported by natural means across the intervening ocean. In the majority of cases, these species are indigenous, i.e., quite distinct from the mainland species of the same genus or family. Thus, the fauna and flora of the Galapagos Islands, 500-600 miles from the South American mainland, while distinctly American in character, are in great part indigenous. The island of St. Helena is 1200 miles from Africa and 1800 from America; it has no land vertebrates, an indigenous species of land bird, 20 species, all indigenous, of land snails, and 129 species of beetles, of which 128, grouped into 25 genera, are indigenous. In general, oceanic islands are devoid of terrestrial mammals; they often have bats, which, like land birds, could be blown from the mainland; the eggs or larvae of snails would be brought in the mud clinging to the feet of birds, and the beetles, whose larvae live in wood, would be brought in by driftwood. It is unreasonable, Darwin argued, to regard the species on these oceanic islands as specially created. The only reasonable conclusion is that they are descended from an ancestral form

[141] L'Encyclopédie Francaise, loc. cit.

belonging to a different species and living on the mainland, having diverged from it because of the different organic environment and the different requirements of the struggle for existence in this new environment

Another fact from which Darwin drew the same conclusion is the similarity between the species that constitute the faunas and floras of the continents Thus, the mammalian species of South America, Africa, and Australia form three groups, the members of which have distinctive features enabling us to identify them as belonging to their particular continent We find, for example, that there are no placental mammals, except bats, in the fauna of Australia, there are a few monotremes and all the rest are marsupials. The only marsupials found in South America are the opossum and the shrewlike *Caenolestes* The similarity between the forms of each continent is to be explained by their descent from a common ancestor, while the dissimilarity between them is due to variation and natural selection, and perhaps also, in a lesser degree, to the influence of different physical conditions Hence all the marsupials of Australia are descended from one ancestral form that migrated there to escape extermination by the more powerful placentals, and, being isolated when Australia was cut off from the rest of the world, gave rise to a great variety of forms—herbivorous, carnivorous, rodent, insectivorous, etc The case of the marsupials would be similar to that of the tapirs, a sub-family of placental mammals, that once inhabited Europe and North America, and is now found only in Central and South America, the Malay Peninsula, Java, Borneo, and Sumatra As the tapirs were driven to their present abodes by more powerful placentals, so the marsupials would have been driven to the forests of South America and to Australia by the placentals, which evolved after them

Do the facts of biogeography, we ask, warrant these conclusions?

The character of the faunas and floras of oceanic islands certainly shows that when living forms pass into new surroundings they often undergo a considerable amount of change This change seems to be due much more to the inbreeding that results from isolation and to the influence of the geographical environment on all its occupants than to natural selection Moreover, it is often doubtful whether there is a true specific difference

between the form found on the oceanic island and the corresponding form found on the adjacent mainland "The more any group is studied," writes Mayr, "the more geographical races are found, and groups previously classified as species are found to be geographic races of polytypic species"[142] We may admit, however, that new species may develop by the geographical isolation of a population over a period long enough for it to acquire characters that make it no longer fertile with the parent species Even Goldschmidt, who denies that species are actually formed in this way, admits it as a theoretical possibility[143] Granting, then, that true species have been produced on oceanic islands by geographical isolation, what follows? In Darwin's view, this was enough to establish the possibility of the widest form of evolution, for, as Goldschmidt says, "he took it for granted that an explanation for the origin of species automatically also explains the origin of the higher systematic categories by the same process found to be involved in the origin of the lower categories"[144] This assumption of Darwin's, as we have pointed out already, is not justified, for a merely specific change does not alter the basic structure of the organism, and it is the origin of types that differ basically in their structure that is the main problem The origin of a distinct species by evolution suffices to disprove Fixism, but it has no bearing on the thesis of Extreme Evolutionism Indeed, the inferences to be drawn from the character of the faunas and floras of oceanic islands are unfavourable to Extreme Evolutionism, for many of these islands are very ancient, and yet at no time in their long history were their vacant ecological niches filled by marine organisms that came ashore and adopted a terrestrial mode of life Furthermore, if Extreme Evolutionism be true, these islands should contain many peculiar orders and families In fact, there are none, there are peculiar species and genera, and perhaps two sub-families (the birds *Drepanidinae* and the gastropods *Achatinellinae*, of Hawaii) but that is all It seems, therefore, that a living form can be altered only to a limited extent by isolation in a different geographical environment

[142]Systematics and the Origin of Species, p 141
[143]The Material Basis of Evolution, p 169
[144]Ibid, p 31

The evolutionary explanation of the marsupial character of the Australian fauna has very little evidence to support it The theory supposes that the placental mammals have arisen by evolution from some marsupial stock, but the findings of palaeontology do not bear out this view, for the earliest marsupial fossil is from the Upper Cretaceous, whereas the earliest placental fossils are also from the Upper Cretaceous, or even, according to some, from the Triassic Secondly, while it is possible to trace the migration of the tapirs, which appear in the Eocene and onwards in North America, from the Oligocene to the Pliocene in Europe, and from the Miocene onwards in Asia, it is not possible to trace any such migration in the case of the marsupials Let us admit, for the sake of argument, that all the Australian marsupials are descended from a single ancestral type (a thesis that is very far from being proven). It is curious that during the 120 million years that have elapsed since Australia was isolated in Cretaceous times, the marsupials have never given rise to a ruminant, or a perissodactyl, or an aquatic or flying form, or a primate, and still less to any placental type The fact is not easy to reconcile with the theories of Extreme Evolutionism

Biogeography, therefore, draws our attention to various factors that probably account for the origin of minor systematic diversity, but as Julian Huxley says, "the origin of minor systematic diversity seems to have little to do with the major processes of evolutionary change"[145] And the problem that concerns us is the origin of the great groups, "the major processes of evolutionary change"

SYSTEMATICS

Systematics, or taxonomy, is the science of classification We have seen how the plant and animal kingdoms are each divided into progressively smaller groups, the members of a small group, such as the species, resembling one another more closely than do those of a larger group, such as the order or class There is no dispute among biologists about the possibility of classifying the animal world, nor is there any dispute about the main lines of the classification All, for example, accept the existence of such groups as fishes, arthropods, birds, without question, and

[145]Evolution, the Modern Synthesis, p 153

they have no doubt about which of these groups a given organism is to be assigned to It is on minor points that opinions differ, e g , regarding the number of species in a genus, or the genus to which a particular species belongs

There are, however, serious differences of opinion regarding the significance of classification Darwin argued that, although the systematist arranges his groups according to resemblance, "some deeper bond is included in our classifications than mere resemblance I believe that community of descent—the one known cause of close similarity in organic beings—is the bond, which though observed [obscured?] by various degrees of modification, is partially revealed to us by our classifications "[146] The classification of the systematist is therefore to be interpreted as a genealogical table In the course of time, some lines have become extinct, others have given rise to great numbers of species differing widely from one another, while others have hardly varied at all "The natural system [sc of classification]," Darwin declared, "is genealogical in its arrangement, like a pedigree but the amount of modification which the different groups have undergone has to be expressed by ranking them under different so-called genera, sub-families, families, sections, orders, and classes "[147] The gaps between the various groups are explained by the extinction of the intermediate forms "Extinction has played an important part in defining and widening the intervals between the several groups in each class We may thus account for the distinctness of whole classes from each other—for instance, of birds from all other vertebrate animals—by the belief that many ancient forms of life have been utterly lost, through which the early progenitors of birds were formerly connected with the early progenitors of the other and at that time less differentiated vertebrate classes "[148]

The Darwinian conception of classification as a genealogical table is incompatible with the fact that there is no sign in the fossil record of the intermediate forms that such a theory requires

It is sometimes said by those who should know better that the evolutionary conception of genealogical relationship is the

[146]The Origin of Species, p 342
[147]Ibid , p 347
[148]Ibid , p 356

only means of reducing to order the chaotic mass of facts that confronts the observer when he begins to study the various forms of plant and animal life The truth is that classification is still based, as it was in the days of Linnaeus and Cuvier, on non-evolutionary principles, the genealogical conception is not used to create order, but simply to interpret in a particular manner an order already established on other grounds. "Our modern systems of classification," wrote Radl, "are also very like that of Cuvier Compare the modern subdivisions of the animal kingdom with Cuvier's types (Vertebrates, Molluscs, Articulata, Worms, Radiata) We do not find the word *type* in the modern classifications The number of subdivisions has been increased We recognize an important innovation in the introduction of the Protozoa, but otherwise the whole picture fits very well into the frame of Cuvier's scheme"[149] More recently, Julian Huxley has drawn attention to the same truth, pointing out that "taxonomic practice was actually little altered by the introduction of the idea of evolution and phylogeny into biology"[150]

Phylogeny is based on classification, and classification is based, as in Cuvier's day, on morphology Mayr is therefore putting the cart before the horse when he writes "We may say that the natural system of the modern taxonomist is based on phylogeny, and that the higher categories are monophyletic units The phylogenetic system of the higher categories is not only the inevitable consequence of the acceptance of the theory of evolution, but it also guarantees a greater number of joint characteristics to the members of the various units than any other principle of classification so far proposed"[151] Phylogeny, we repeat is not a principle of classification, but simply an interpretation of the natural system established on morphological principles The classification may indeed be expressed in phylogenetic language, but the realities are morphological

The phylogenetic interpretation of classification has, in truth, been destructive rather than creative of order in biology, for it proceeds on the assumption that the differences between species or genera are essentially the same as differences between the higher categories Mayr, for example, after discussing the objective character of the genus and arriving at certain con-

149The History of Biological Theories, p 188
150Evolution, the Modern Synthesis, p 401
151Systematics and the Origin of Species, p 280

clusions, uses these conclusions as the basis of a generalization about the higher categories, such as class and phylum In this he is a true disciple of Darwin, who, as we have pointed out, failed to distinguish between the differences that affect basic structure and those that do not, confusing a theory of the origin of species with a general theory of evolution

When the biologist adopts the phylogenetic interpretation of classification, he is liable to lose sight of the important truth that the higher categories are determined by considering basic structure and the manner in which the various apparatuses are correlated and adapted to its mode of life, and *not* by speculations about phylogeny, past or future Mayr provides us with an illustration of this mistake, when he writes "What are the 'macrotaxonomic' characters? We can determine this only *a posteriori* They are the attributes of higher categories But it would be impossible to look at contemporary genera and to state which of them would become the ancestors of important families and orders of the dim future"[162] For the taxonomist, the "higher categories" are not "the ancestors of important families and orders," as Mayr suggests, but "groups of organisms that resemble one another in points that are morphologically important"

Within the kingdom, the phyla differ profoundly in their structure, e g, arthropods and worms Within the phylum, the classes are distinguished by the particular arrangement of certain apparatuses, e g, the respiratory system is different in fishes, birds, and mammals The organization common to the orders of a class is found in each order in a specialized form, being adapted to the particular alimentation and mode of life of the order, all bats have wings, all cetaceans have flippers, the paw of the rodent differs from that of the ruminant, etc Within the order, the families are distinguished by their general contour and deportment, thus the bear, with its flat foot, differs from the dog, with its thin, digitigrade foot Within the family, the genus is distinguished according to the number of its teeth, the shape of its claws, etc Within the genus, the species are distinguished from one another by details of external shape, the proportion of parts, colour, size, etc Obviously, species classi-

[162] Systematics and the Origin of Species, p 298

fied on this basis might be fertile if mated, and so in reality merely races. But although there may be some doubt about where the distinction between species is to be drawn, it is clear that the distinction between phyla, classes, and orders differs in kind, and not merely in degree, from the distinction between families, genera and species A category is higher, not because it is more extensive, but because its distinctive characters are more significant Hence we must reject as erroneous Mayr's statement that "the value of a character is determined primarily by the size of the group which exhibits it"[153] The value of a character is determined primarily by its connection with the mode of life of its possessor, its significance as revealing the nature of the animal Thus the monotremes, a sub-class comprising only the echidna and the platypus, constitute a category of equal rank with the far more numerous placentals Even if there existed only one species in the world, it would embody within itself all the categories of systematic classification, for it would possess a general structural plan (phylum), realized in a certain way (class), presenting a form more or less specialized (order or family), having some particularity of structure that is of some moment (genus), and special traits of stature, colour, etc (species) If we may be permitted to express the matter in terms of logic, the systematic value of a character or complexus of characters is primarily determined by its connotation or comprehension, not by its denotation or extension.

To sum up, the facts of systematics lend no support to the theories of Extreme Evolutionism, for the natural system of Linnaeus and Cuvier, which conceives of the organic world as a hierarchy of stable forms, each clearly marked off from the others, has not required any substantial alteration to enable it to accommodate the vast numbers of new forms, living and extinct, that have been discovered since it was put forward. It is possible that the distinction between species is not so rigid as Linnaeus and Cuvier thought (although most modern species are sharply separated from one another), but on the question of the objectivity and stability of the higher categories, it is their conception, not that of Lamarck and Darwin, that has been vindicated by the research of the last one hundred years

[153]Systematics and the Origin of Species, loc cit

PARASITOLOGY

Parasites are organisms that exist either upon or in other organisms and nourish themselves on their living substance or the nutritive sap they have prepared. Most parasites are adapted morphologically and physiologically to this peculiar mode of life, morphologically, in so far as their bodily structure is arranged to suit this manner of acquiring their sustenance, and physiologically, by the fact that they cannot exist without the nutrition to be derived from a definite species or group of related species.

There are many reasons for thinking that these parasitical organisms were once free-living forms and have since adopted a parasitical mode of life, acquiring in the process the adaptations that fit them for this mode of life. In the first place, there are certain parasites that can live only in one kind of organism, or even in one organ. For example, the larval form of the tapeworm can develop only in the brain and spinal cord of the sheep, and the malaria parasite can complete its reproductive cycle only in the intestines of the anopheles mosquito and the red corpuscles of man. It is most unlikely, to say the least, that this is the original state of things. Secondly, parasites do not constitute a distinct genus, but parasitical forms are scattered through many genera. Hence it looks as if some members of these genera have adopted the parasitical mode of life, while others have remained free-living. Thirdly, the larvae of some parasites resemble those of other, free-living types, and this seems to show that the adult parasite has become degenerate through parasitism.

The most probable explanation seems to be that the parasite has been a free-living form at first, afterwards adopting the parasitical mode of life, and in many cases has become progressively specialized to meet the requirements of this new mode of life, sometimes to such an extent that it depends completely on its particular host for its continued existence as a living form. The atrophy of certain organs would be rather specialization than degeneration, since it makes the parasite better adapted to its new mode of life.

If such changes have taken place, they show that a living form can undergo a good deal of modification, the parasitical descendants differing from the ancestral free-living form to such an extent that on morphological grounds they would be reckoned as at least specifically distinct from them. It has to be borne

in mind, however, that no one has ever witnessed the transformation of a free-living form into a parasite, so that the nature of the free-living ancestors of forms now parasitical can only be inferred with more or less probability. Moreover, parasitical forms fit into the ordinary classification, so that such evolution as they may have undergone has not led to the origin of any important category of organism Finally, the evolution of parasites generally implies a loss of structures, and does not bring us any nearer to a solution of the main problem that concerns us—the origin of organic types possessing structures previously unknown.

A phenomenon similar to parasitism is the existence in colonies of ants and termites of "guests," insects of various sorts, mostly beetles, that possess bodily adaptations of the most diverse character fitting them for the myrmecophile or termitophile mode of life Some of these "guests" closely resemble the ants in appearance and are treated by them as equals; others possess organs that exude a sticky substance used by the ants for food. The adaptive characters that fit the "guests" for this mode of life convert the forms concerned into proper systematic species, genera, sub-families and even families, which differ considerably from allied forms that do not associate with ants or termites Thus in the beetle family of the Staphylids, there are in the group of Lomechusini three genera, containing twenty-five species, which by their peculiarly broad bodily form and the arched sides of the thoracic shield, and particularly by the yellow bunches of hairs on the hinder side of the body, differ strikingly from the rest of the Staphylids These morphological peculiarities which differentiate them from the other Staphylids are adaptive characters fitting them for their life as "guests" of the ants

Palaeontology reveals that the systematic orders to which the "guests" belong appeared much earlier in the world's history than the ants and termites It is probable, therefore, that some of these insects found it convenient to live with the ants and progressively adapted themselves to this mode of existence. Such adaptations, however, have not altered the basic structure of the "guest," which remains a beetle, fly, or spider, as the case may be Wasmann, who devoted his life to the study of ants and termites and their "guests," came to the conclusion that

accommodation to the life of ants and termites has in all probability led to the formation of new species, genera, and families among their "guests," but has certainly not led to the formation of any higher categories In his view, such evolution has remained within the limits of the "natural species" that was "originally in its primitive form produced directly by God out of matter "[154]

NATURAL HISTORY

The phenomena of mimicry, protective coloration, and protective resemblance have often been considered as the final result of a process of evolution We shall deal with them briefly, following in the main Berg's treatment of the subject [155]

Mimicry Certain inoffensive animals externally resemble others inhabiting the same locality that possess poisonous or stinging organs or some other means of defence and are invulnerable to the attacks of enemies Thus an Indian cuckoo greatly resembles an Indian hawk, some staphyline beetles resemble their ant hosts, flies of the genus *Volutella* resemble the bumble-bees in whose nests they lay their eggs

The Darwinian explanation of mimicry was that slight accidental modifications leading in the direction of copying the model were useful to the inoffensive imitators, and these variations were preserved and steadily increased in the same direction by natural selection, until the mimicking type came to bear a close resemblance to its model

This explanation of mimicry will not hold water, because it is often doubtful whether mimicry confers any benefit on the mimic, and in cases where it does, its existence cannot be explained by the action of natural selection Our reasons for rejecting the Darwinian view may be summed up as follows

First, many cases are known where the imitated and the imitator inhabit different continents Thus, an African wagtail *Macronyx croceus* mimics a North American troupial *Sturnella magna*, the New Zealand cuckoo *Urodynamis taitensis* closely resembles the American Hawk *Accipiter cooperi* Two Argentine butterflies closely resemble the European *Vanessa prorsa* and *V levana*, the butterfly *Papilio polytes* has three female forms, one resembling the inedible *P hector*, another resembling the

[154]Modern Biology and the Theory of Evolution, p 428
[155]Cf Berg, Nomogenesis, ch VIII, pp 314-338

inedible *P. aristolochiae,* and the third resembling the male of its own species, but the form resembling *P. aristolochiae* is sometimes very abundant where *P aristolochiae* itself is rare, so that its mimicry is useless.

Secondly, there are many cases of entirely useless mimicry among types inhabiting the same territory Thus, the diminutive moth *T pronubella* mimics the large moth *Agrotis pronuba;* sometimes butterflies mimic wasps, which are the prey of bee-eating birds, in many cases the resemblance between the mimic and the type it mimics ceases when the mimic is on the wing, similarly, there is mimicry among nocturnal animals, to which it could not be of any benefit

Thirdly, many butterflies that are vigorously attacked by birds show no tendency to mimic, whereas allied species in the same area mimic

Fourthly, mimicry cannot be explained by the selective accumulation of micromutations, because these have no selective value until the change is complete.

When mimicry exists, it may be of benefit to the organism that mimics, although McAtee concluded from his investigation that "insects supposedly poisonous, distasteful and protected by concealing or warning coloration are destroyed by birds in great numbers"[156] It is not caused by a slow process but seems to be the result of a mutation which, because of a certain similarity in the germinal material of the two types, causes the mutant to resemble an already existing form Thus the staphyline beetles that are ant "guests" may have acquired their resemblance to their ant hosts by a sudden mutation and afterwards have come to resemble them more closely through inbreeding and the influence of the environment

Protective coloration Animals and plants are often coloured in such a way as to be difficult to distinguish from their surroundings, e g, the polar bear is white According to the Darwinian theory, the white polar bear would be the result of a process of natural selection that has eliminated all the dark ones This is not a probable hypothesis, for in the same surroundings the dark walruses and seals manage to survive There is no satisfactory explanation of protective coloration, but the influence

[156]McAtee's finding summarized in Dobzhansky, Genetics and the Origin of Species, p 164

of food and climate on the organism probably has something to do with it, and it may be that some organisms have the power of modifying their coloration by automatically regulated processes so as to resemble their surroundings more closely. For example, the turbot can vary its coloration to match its surroundings if it is not blind, and this faculty improves with exercise Some cod are reddish-brown, others grey, and they can change their colour to make themselves less conspicuous *Percottus gleckm*, a black fish from the Amur, will in 5-10 minutes turn light yellow if it is placed in a white metal dish The newt can change its colour by the contraction and expansion of its dermal pigment cells Some faculty analogous to this probably explains the existence of protective coloration in so many organisms

Protective resemblance Protective resemblance is a more striking phenomenon than protective coloration and consists in this, that the organism in its whole aspect resembles its surroundings For example, the plant *Mesembryanthemum calcareum* is very like the tufa on which it grows, the poisonous fish *Emmidrichthyes vulcanus* of Tahiti is very like the lumps of lava among which it lives, sea-horses resemble seaweed, the Malayan spider *Ornithoscatoides decipiens* is very like freshly-dropped bird's dung No satisfactory explanation of this phenomenon has been provided On the Darwinian theory, protective resemblance would be due to an accumulation of chance variations preserved by natural selection; but this may be dismissed as too far-fetched to deserve serious consideration In certain cases, the resemblance may be due to the animal's choosing a habitat similar to the colouring and shape of its body

A similar phenomenon is the fearsome appearance of certain harmless caterpillars It is most unlikely that the caterpillars acquired this frightening aspect gradually by natural selection, for while they were acquiring it, the birds would surely learn with equal rapidity to penetrate this disguise, even as they soon learn not to fear scarecrows, so that the variation in the direction of an awe-inspiring appearance would confer on the caterpillar no advantage in the struggle for existence

Mimicry, protective coloration, and protective resemblance are interesting phenomena, and difficult to explain They cannot be accounted for in terms of Darwinism, Lamarckism, or

Mutationism, but it may be possible to devise an evolutionary explanation that would incorporate elements from each of these theories and provide a sufficient reason for the facts Such a theory, however, would have no bearing on the problem that concerns us, for the changes it would postulate would be superficial, leaving the basic structure of the organism unaltered, changes of this kind lend no support whatever to the thesis of Extreme Evolutionism

4

CONCLUSIONS

Now that we have surveyed the principal facts bearing on the problem of the origin of diversity in the plant and animal kingdoms, we are in a position to pass judgement on the solutions that have been put forward

Despite the production of new plant forms that are apparently true species, e g , *Primula kewensis* and *Raphanobrassica,* it can hardly be said that Fixism has been completely disproved Species really do exist as natural biological entities, sharply defined and separated from one another by gaps that are bridgeless as a rule, it is not absolutely certain that the inter-specific gap has been bridged by the production of these new species, which might not be able to survive in natural conditions

But if Fixism has not been conclusively disproved, it cannot be said to be probable On the Fixist hypothesis, every distinct species would have been directly produced by God, thus the horse, the ass, and the zebra would each have come into existence as the result of a special exercise of Divine causality It is, however, an axiom of philosophy that an effect is not to be attributed to the direct action of God if it can be accounted for by natural causes, and although it has not been strictly demonstrated that natural causes can bring new distinct species into existence, it seems highly probable that they can do so and have done so It may well be that the horse, the ass, and the zebra are descended from a common ancestor, for they are very similar in structure and their present inability to produce fertile offspring when crossed may easily be due either to a sudden mutation or to a process of gradual variation in the isolation of their respective habitats Similarly, it is clear from palaeontology that various organic types have undergone extensive morphological changes in the course of time, and although it is

not possible to determine by crossing whether the various descendants of the original type would be fertile with one another or with the ancestral type if they were crossed, the extent of the morphological changes suggests that they would not.

The theories of Extreme Evolutionism fall into two groups—Lamarckism and Darwinism, which attribute the diversity of the organic world to a process of gradual change, and Mutationism, which assigns the principal role in evolution to sudden immense mutations

The development of the organic world has certainly not taken place in the manner described by Lamarck and Darwin Their theories demand perfect continuity between all the branches of the phylogenetic tree, and if these theories readily admit the extinction and disappearance of some intermediate forms, they demand none the less that most of the branches run into one another, and that the bonds between present and past forms of life be as multiplied and as direct as possible. They need to have animals and plants succeeding one another in such a way that the most recent are the descendants of their predecessors and the types genetically connected in the order their relative complexity would lead one to suppose The facts of palaeontology show that none of these requirements of the Lamarckian and Darwinian theories is fulfilled The development of the plant and animal worlds is discontinuous, and there is no necessary relation between the geological age of a type and its anatomical complexity

We do not see at each epoch a simple succession of consecutive forms in regular series, as these theories suppose, forms solely occupied in evolving, but we see forms co-ordinated so as to form a coherent whole, enclosing the diverse degrees of complexity and power that living beings can possess strong and weak, humble plants and magnificent trees, with the different animal and plant associations that one finds in all faunas and floras In order to realize these varied complexuses or co-ordinated wholes, nature can utilize, from the beginning, the first forms that appear, to make of them the most powerful species, without waiting for a long period to elapse before they attain to this state by a series of gradual increases in perfection If trees are needed, she gives to cryptogams the necessary strength to fulfil this role, if she needs a powerful class of

terrestrial vertebrates, capable of dominating the world in Primary times, she produces giant amphibians, the Stegocephali, more complex and better armed than the amphibians of the present day Thus palaeontology provides us with the spectacle of a series of successive living worlds, to the number of about twenty, each one formed at its epoch of different morphological types—of an increasing perfection, it is true—but of which each can give, during the epoch in which it predominates, all the essential forms required for the complete expansion of life At any moment, there exists a world very differentiated and complete, comprising all the degrees of variety required to ensure an impressive display of the potentialities of life Even when no vertebrates exist, their place is taken by Gigantostracea and Cephalopoda, powerful and active animals of prey, able to cause in matter the changes necessary for the realization of countless forms of life.

Hence at every stage of the development of life, there exists an order far exceeding any that could result from chance variations or the efforts of organisms to adapt themselves to their environment The fact is that this order is not established at the end of a long space of time, but is visible at the beginning of things Reflection shows, moreover, that this must have been the case From the beginning, there must have been creators of organic matter—the plants, and also beings capable of employing this organic matter for something else besides organic synthesis, and notably, for sensori-motor activity There must have been destroyers of dead matter, to free the chemical elements contained in it and thus set them once more into circulation for the life-cycle Furthermore, besides these indispensable agents, there must have been others to maintain the composition of the surroundings required for life, to keep the air and the waters habitable The antecedent probability—a probability that approaches certainty—that life did not begin as a single living form, but as several living forms concurring to ensure the life of all, is corroborated by the evidence As soon as fossils appear, they belong to several phyla and constitute a complete living world, in which all the functions necessary for the continuance of the whole complexus are assured The subsequent development to which the fossils bear witness is not a development of biological groups proceeding in the order of

increasing complexity, but a development obeying the necessities of the whole complexus of living things

There is no doubt that the organic world has in the course of its history undergone considerable development or evolution, but this evolution, at least in its main lines, has been totally different from the evolution described by Lamarck and Darwin

As there has been no gradual development of complete organisms, neither has there been a gradual development of organic apparatuses The perfection of an organic apparatus, e g, the respiratory apparatus, in one type, is discontinuous with its perfection in another type The perfection of an apparatus in each type is determined by the needs of the type to which it belongs, not by the place this apparatus occupies in the historical series of the forms which it has taken As the types have appeared suddenly, so have the apparatuses It is idle, therefore, to form hypotheses to explain how such things as the teeth or the papillae originated. All the evidence goes to show that they came into existence suddenly All the apparatuses must from the beginning have possessed a degree of organization sufficient to ensure that the organism possessing them was viable

The Lamarckian and Darwinian theories are therefore untenable as explanations of the origin of the principal forms of organic life, diversification within fairly narrow limits may have been effected more or less along the lines they describe, but not the important changes resulting in the appearance of new phyla, classes, or orders [1]

Not only are these theories contradicted by the facts, especially the facts of palaeontology, but the factors they invoke are quite inadequate to account for the changes they attribute to them We shall briefly consider each of them from this point of view

It is a fact in Lamarck's favour that the organism has the power of adapting itself to a certain extent to meet new conditions, e g, a cow grows a thicker coat in a colder climate, walking barefoot makes the skin on the soles of the feet thicker But this power of adaptation is limited, so that the cow, for example, cannot adapt itself to an aquatic life It should be noted, furthermore, that such adaptations are to be attributed

[1] Cf Vialleton, L'Origine des Etres Vivants, pp 338-360

to an active power in the organism, for they are purposive or beneficial to the organism. It is absurd to explain them, as some neo-Lamarckians have done, as changes produced in a wholly passive organism by the action of the environment. It is clear that the adaptation is the result of activity on the part of the organism, which alters itself to meet the change in its environment, because there is co-ordination, e.g., if the bones of a limb are elongated the muscles, nerves, and blood-vessels are elongated in proportion. Lamarck's theory presupposes that the living thing is preordained to a specific reaction that is generally useful, and the attempt of some neo-Lamarckians to give the theory a mechanistic interpretation makes it self-contradictory.

The fundamental tenet of Lamarckism is that adaptations acquired by the parent are transmitted to the offspring. *A priori*, it seems probable that this should be so, that the changes occurring in the body of the parent should be reflected in the constitution of its germ-cells. Weismann, however, put forward in 1883 the theory that changes in the somatic or body cells do not affect the germ cells, because germ-plasm is a special kind of substance, which can be formed only from germ-plasm, is quite different from somatic plasm, and cannot be influenced by any changes that take place in somatic plasm. Weismann's theory is no longer tenable. "On the modern view of the germinal substance, conceived as having its seat in the chromosomes, and as being exactly divided quantitatively and qualitatively in every mitotic division," wrote E. S. Russell, "Weismann's conception of the separateness of germ-plasm and somatic plasm is seen to have no foundation in fact. ... From Morgan's studies of the regeneration of the Planaria, it is clear that new germ-cells can develop from the somatic tissues or at least from cells not included in the old reproductive system."[2] However, if we reject Weismann's theory, this does not necessarily mean that we affirm the inheritance of acquired characters. L. Cuénot, writing in 1927, declared that there had never been a clear, confirmed, decisive experimental proof of the patrimonial inscription of characters first acquired by the soma, and that is still the position.

But if it is not certain whether acquired characters can be acquired by heredity, it is certain that the Lamarckian evolutionary

[2]The Interpretation of Development and Heredity, p. 291

factors cannot explain the origin of an organ or of an organic type. It is false to say that the function creates the organ, for the simple reason that the function is impossible without the organ If an animal does not possess wings or wing-like structures, it cannot fly Hence we reject as absurd Mayr's statement that "structure did not precede function, nor function structure "[3]

Lamarck suggested that the origin of tentacles in a gastropod could be explained by the transmission of fluid by the gastropod to its extremities in order to fulfil its desire of seizing bodies near it It is impossible to conceive how such a cause could produce such an effect, for these organs are complex structures, specially adapted to their functions, and more than desires would be needed for their formation. The Lamarckian account of the formation of complicated organs such as a tentacle or a wing can only be described as fantastic. When the structure exists, the exercise of the activity for which it is destined will often no doubt cause modifications in it, but not such as to change it into a completely new structure It is to be noted also that the constant use of organs does not always perfect them, for the eyes of scholars become myopic and teeth wear out

If the exercise of activity cannot give rise to a new organ, still less can it give rise to a new organic type For an organism to be altered sufficiently to pass from one phylum, class, or order to another, much more is needed than the modification of one or two organs Everything in the organism must be changed, and changed in such a way that the necessary correlation of parts is secured Lamarckism, as Driesch pointed out, would make such correlation the product of uncoordinated contingent changes, and, Driesch added, "that specific organization proper is due to contingent variations, which accidentally have been found to satisfy some needs of the individual, and therefore have been maintained and handed down is quite an impossibility "[4] Differences in the environment do not provoke profound changes in the organism, as is clear from the nature of deep-sea animals. Although the conditions in the ocean depths are utterly different from those at the surface, there is not one order of animals known to us from the oceanic depths alone The forms of

[3]Systematics and the Origin of Species, p 291
[4]The Science and Philosophy of the Organism, p 179

organic life develop within such relatively narrow limits that even such very different environmental conditions have not altered more than minor details in the structure of these animals[5]

The distinctive feature of Darwin's theory lies in the importance it attaches to natural selection, which Darwin regarded as "the most important means of modification" causing change in organic forms

Although the theory lingers on in popular treatises, in the scientific world it is dead, and even those who call themselves Darwinians, e g , Julian Huxley and J B S Haldane, admit that their version of Darwinism differs considerably from Darwin's. It is, as Julian Huxley put it, a "mutated Darwinism", in this case, we may add, the mutation has certainly involved a change of species Much can be learned, however, from a post-mortem, and so we shall consider briefly why Darwin's theory died[6]

In the first place, the theory is incoherent, for it attempts to explain living bodies without admitting purpose, and yet the principles that are to eliminate purpose from nature imply that there is true purpose in nature For example, Darwin attempted to explain the vertebrate eye, not as a structure formed for the purpose of seeing, but as the result of chance variations that have accumulated by the action of the blind force of natural selection, and he had a similar explanation for all the other manifestations of purpose in organic nature, everywhere he put blind necessity in the place of final causes But, as Berg and others have pointed out, Darwin's explanation itself supposes the existence of the final causes that he strove to banish from biology The struggle for existence is unintelligible unless we assume that the organism is ordained to life The organism struggles to exist, because the preservation of its own life is the purpose to which it is ordained Similarly, heredity is unintelligible unless we admit final causes—the organism has the capacity to produce offspring like itself *in order* that the type may be preserved in existence

[5]Cf Radl, The History of Biological Theories, p 207

[6]For an exhaustive and able critique of Darwinism cf Robson and Richards, The Variation of Animals in Nature, Longmans, London 1936, pp 181-316

It is the philosophical nemesis of Darwin's rejection of final causes that he falls into ultra-finalism in explaining the survival of ornamental characters, he says that these have been preserved and handed on, because they have helped the organism to survive In other words, although nothing has a purpose, these characters have been preserved only because they have a purpose In effect, he has to deny that there are any truly ornamental characters, and in this he has not found many naturalists to agree with him On the other hand, the one who admits that most organic structures exist for the purpose of benefiting the organism can quite well admit that there are some—the ornamental characters—that do not benefit the organism

Darwin laid down without any proof his fundamental principle that nature, in forming species, follows essentially the same methods as the breeder when he wishes to produce a new race, although, as Radl put it, this assertion cries aloud for proof The principle was not proved, and cannot be proved, because it is false There are many things man does that nature by herself cannot do, such as the building of cities and the manufacture of motor-cars, and the selection of specially endowed males and females for breeding purposes also falls within this category "The real rock of Mr Darwin's theory," wrote Paul Janet, "the dangerous and slippery point, is the passage from artificial selection to natural to establish that a blind nature, without design, can have attained, by the coincidence of circumstances, the same result that man obtains by reflecting and calculating industry "[7]

On the evidence, artificial selection is a much more powerful cause of variation than natural selection, for in those cases where survival is determined by natural selection, it is the mean type that is favoured rather than the variations "As far as may be judged from the available data," wrote Berg, "natural selection cuts off deviations from the standard, by destroying extreme variations "[8] Guyénot also came to the conclusion that "natural selection, contrary to what Darwin thought, has a conservative effect, and limits the variability of species "[9]

[7]Final Causes (Tr Affleck), Clark, Edinburgh, 1878, p 277
[8]Nomogenesis, p 63
[9]L'Encyclopédie Francaise, V 20 12

The efficacy of artificial selection is very limited, for although the breeder can by appropriate crossing produce new varieties of domestic animals and cultivated plants, he soon reaches a barrier beyond which he cannot go. If the specific form is modified beyond a certain limit, it ceases to be viable.

Natural selection does occur in nature, for it is obvious that, other things being equal, an epidemic will carry off the sickly members of a species rather than the strong, but the phenomenon is far less universal than Darwin imagined. As Kleinschmidt pointed out, the species mostly ignore one another, and where one preys on another a kind of symbiosis is formed, which holds the balance between production and consumption: the lion preys on the antelope, but kills just enough to satisfy his needs. Furthermore, in so far as the fate of the antelopes is determined by their speed, the lion would catch the slowest of them, but those of average speed would escape just as well as the faster ones, and so natural selection would not be selective enough to cause any change of speed in the antelope. If Darwin's theory that only the fittest survive were true, the giraffe would become extinct in a generation, for the male has a longer neck than the female or the young ones.

If natural selection is to work, survival must depend as a rule on fitness. In fact, survival does not depend as a rule on fitness, but is much more frequently determined by chance, for the elimination occurs mainly in the egg stage and is due to parasites, climatic changes, beasts of prey, etc. The survival of animalcules in the plankton is determined by their position when the fish that lives on them opens his mouth, and the fate of the antelope that furnishes the lion with his dinner is determined mainly by his position in the herd when the lion comes upon them.

The theory of natural selection attempts to explain the origin of complex structures by the accumulation of minute variations, each of which is preserved because of the advantage it confers on its possessor in the struggle for existence. In this the theory is self-contradictory, for such variations would be of no advantage in the struggle for existence. The whalebone of the whalebone whales, for example, is said to have been gradually evolved from teeth, but such whalebone in the process of formation would be a disadvantage not an advantage, since it

would be unable to perform the functions of either teeth or whalebone. *A fortiori,* natural selection could not bring about the great changes required for the evolution of one order from another, since these must all be produced instantaneously and together for the organism to survive

These are some of the difficulties that have, to quote J. B. S. Haldane, "led many able zoologists and botanists to give up Darwinism"[10] It is remarkable that the theory remained in the ascendant for so long, for as Driesch wrote, "a searching analysis of the Darwinian factors of evolution should have led to their rejection from the very beginning"[11]

The theory of evolution by immense mutations escapes many of the difficulties that beset Lamarckism and Darwinism, but it amounts to little more than the bald assertion that such mutations have taken place, for it cannot explain how they would have been accomplished nor indicate any natural causes capable of bringing them about Science knows of small mutations that modify the organism in some particular without altering the specific type, but it knows nothing of mutations involving a change from one order or class to another Furthermore, if such a mutation did occur, e g, if the offspring of a fish were an amphibian, it is quite certain that the result could not be due to chance, for chance could not secure the coördination of all the modifications required to produce a completely new and viable type To attribute such a mutation to the potentialities of living matter as found in the original type is to assert more than the facts warrant, for there is no evidence that the original type possesses such potentialities, and if it did possess them, the question arises Whence did it derive these potentialities? If the mutation is attributed to a special exercise of Divine causality, the thesis of Extreme Evolutionism is abandoned

As the evidence stands at present, the only probable hypothesis is some form of Moderate Evolutionism There seems to have been a good deal of diversification within the limits of the genera and families, and it is even possible that certain families belonging to a common order, e g the Cat, Dog, and Bear families, belonging to the order of Fissipede Carnivores,

[10]The Causes of Evolution, p 113
[11]The Science and Philosophy of the Organism, p 168

have arisen from a common stock The probability that orders belonging to the same class have arisen from a common stock is nil, and the same is to be said of the classes and the phyla

Extreme Evolutionism in its various forms is an obstacle to scientific progress, because it leads those who hold it to misconceive their problems and misinterpret the data they observe If biology is to advance, this theory should be abandoned even as a working hypothesis, and the plurality of living forms should be accepted as an ultimate datum, from which the scientist starts and which he accepts without further question, as he accepts such data as life itself, and the power of living things to absorb food, grow, and reproduce The Darwinians have given up the attempt to explain in evolutionary terms the origin of the power of the organism to heal wounds and regenerate lost parts, when the attempt to explain the origin of the plurality of living forms in similar terms is abandoned, biology will once more regain its full status as a science "The naturalists of the generations that succeeded the publication of *The Origin of Species*," wrote W R Thompson, the eminent parasitologist, "have devoted themselves in great numbers to the creation of evolutionist fiction A good part of the task of the present generation and the next consists in the elimination of these fantastic stories and the re-fashioning of biology according to the plan of the real "[12]

The scientist, therefore, should accept the plurality of living forms as an ultimate datum of scientific experience, leaving this problem like the problem of the origin of life, to be discussed by the philosopher The philosopher has to take account of the scientific facts, but he considers them in relation to the First Cause and not merely in relation to their immediate causes, as the scientist does So far as we can see, the plurality of living forms has no immediate causes, consequently it is outside the province of science and pertains to philosophy

The philosopher, no less than the scientist, has to bow to facts, and the facts all point to the conclusion that a great many living forms have been brought into existence by the direct intervention of the First Cause These forms have come into existence suddenly, and from the first have been well adapted

[12]Le Parasitisme et La Doctrine Transformiste, in coll Le Transformisme, Vrin, Paris, 1927, p 151

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[12]Le Parasitisme et La Doctrine Transformiste, in coll Le Transformisme, Vrin, Paris, 1927, p 151

to the kind of life they have to live, and God, the First Cause, is the only cause we know who is adequate to the production of such an effect There is no philosopher who will find this an attractive conclusion, for the philosopher dislikes what is arbitrary and cannot be deduced, and prefers explanations that attribute effects to created causes and do not require the direct and special intervention of the First Cause. But philosophical preferences must give way to facts, and the facts seem to leave us no alternative

It is not the business of the philosopher to determine the exact number of primordial forms brought into existence directly by God, nor has he to decide whether they were formed out of living or non-living matter It is for the scientist to determine, so far as the evidence will allow, the number of such forms and the extent of their evolution

Neither is it the business of the philosopher to answer questions concerning the manner in which these forms were brought into existence, because the human mind cannot proceed beyond generalities in describing the manner of acting of the First Cause Inability to describe the "how" of a fact is, however, no reason for denying or doubting the fact itself How did the Universe come into existence? How did life begin? How does a material change in the cortex of the brain give rise to a conscious state? How are mind and matter united in man? To these and a thousand other questions we are not able, and probably never will be able, to provide an answer It is the same, we suggest, with the question How did God directly produce the various forms of life?

APPENDIX

THE ORIGIN OF THE HUMAN BODY

ACCORDING to Darwin and Haeckel, man is entirely a product of an evolutionary process of natural selection. They hold that the human mind, as well as the human body, has come into existence by the gradual modification of some lower mammalian type, the immediate ancestor being some form of Old World monkey. We have seen already that the human mind could not have originated in this way, and must have come into existence through the direct intervention of God. But there remains the question: How did the human body originate?

It does not seem possible to answer this question on purely philosophical grounds, for it cannot be shown either that the matter into which God infused a rational soul must have been already animate or that it must have been inanimate. We must then take our stand on the basis of established scientific facts.

If Extreme Evolutionism had proved its case, viz., that the whole animal kingdom, or even the class Mammalia, is descended from a common stock, there would seem to be no valid reason for denying the evolution of the human body from some lower form, e.g., from some kind of ape. If one admits that the elephant is descended from an insectivore, and ultimately from some unicellular organism, it is difficult to see how one can refuse to admit the derivation of the human body from some lower form, such as that of a chimpanzee.

We have seen, however, that the theory of Extreme Evolution is highly improbable, so that its assertions do not create a presumption in favour of the view that the human body is derived by evolution from some non-primate form. We shall therefore restrict our attention to the relation between the human body and the animal forms that most resemble it, considered in the light of zoology and palaeontology.

All those who hold some theory of Extreme Evolutionism agree that the zoological evidence points to a true genealogical relationship between man and the other primates, but there is no agreement about what this relationship is. Sir G. Elliott Smith held that man, Old World monkeys, New World monkeys, and lemurs are all descended from a generalized tarsier closely allied to the Insectivora, each form branching off from the parent stock at different epochs Other writers have put forward other theories, e g., that man evolved from some anthropoid ape stock, that the human line and the anthropoid ape line branched off simultaneously from the primate stock, that the human line is derived from an Old World tailed monkey, that it comes from a very early tarsioid stock.[1]

If the zoological evidence for the evolution of the human body were conclusive, it would indicate the stock from which the human form arose. We may therefore infer from the considerable differences of opinion among zoologists regarding the ancestry of man that the zoological evidence is inconclusive and any genealogical table based on such evidence is mere guesswork.

Nor does palaeontology throw any more light on the subject, for if the fossil remains provided a clear picture of man's descent, the zoologists would be more in agreement than they are

Exponents of Extreme Evolutionism sometimes assert that the evolutionary origin of the human body has been demonstrated by the fossils that have been discovered J. B. S. Haldane, for example, has written that in view of the existence of *Pithecanthropus* and *Sinanthropus*, "it is somewhat ridiculous to talk of the missing link,"[2] and Fr H. J. T. Johnson has written that "the evolutionary hypothesis has been overwhelmingly strengthened by the discovery of fossils bridging the gulf between the human and the simian form."[3] Sometimes, however, they admit the inadequacy of the palaeontological evidence. Thus W. Howells has written that the gap from the ape to *Homo sapiens* is poorly filled, for the relics are exceedingly rare, and again that "there are missing links aplenty in the ancestry of man, but

[1]Cf M Boule, Fossil Men (Tr. J. E. and J. Ritchie), Oliver and Boyd, Edinburgh, 1923, pp 451-457
[2]The Causes of Evolution, p 151
[3]The Bible and the Early History of Mankind, p 9.

the biggest hiatus is not from man down to the ape; it is rather from the ape down to simple primate."[4]

When we examine the palaeontological evidence, we find that the case for the evolution of the human body from some lower form is even weaker than Howells admits. Like the principal forms of plant and animal life, man appears in the strata suddenly and it is impossible to trace his descent from any non-human ancestor. This is all the more curious, because man is the last mammal to appear and the periods preceding his appearance are so rich in mammalian fossils that if the human body really evolved, its evolution should be the easiest for palaeontology to trace.

Fossils of animals resembling lemurs and tarsiers have been found in the Eocene, but there is no trace in these strata of monkeys of any kind, nor of any form that would enable us to link the tarsiers and lemurs with the monkeys. Speaking of the tarsiers that have been found, Raymond says that "although in general form intermediate between lemurs and monkeys, all known tarsioids are too highly specialized to form connecting-links. ... The European tarsioids are somewhat more monkey-like than the American ones, but none has yet been found which could have been ancestral to any of the later anthropoids."[5]

The earliest remains of animals belonging to the monkey tribe are two jaws, named *Propliopithecus haeckeli* and *Parapithecus fraasi*, found in the Fayum debris, belonging to the Oligocene. It is generally agreed that *Propliopithecus* was an anthropoid ape; whether *Parapithecus* was an anthropoid or a tailed monkey is less certain. If both were anthropoids, it would imply that the higher type of primate appeared before the lower.

Jaws have been found in the Miocene that resemble the anthropoid type still more closely—*Dryopithecus, Sivapithecus,* and several more.

Extreme Evolutionists have formulated all kinds of hypotheses regarding the relation of these types to man. Sergi held that *Propliopithecus* is a progenitor of man and is not allied to the modern anthropoids. W. K. Gregory at first made *Propliopithecus* the common ancestor of the modern anthropoids

[4]Mankind So Far, Doubleday Doran, New York, 1944, p. 94.
[5]Prehistoric Life, pp. 277-278.

and man, but afterwards he assigned this role to *Dryopithecus,* holding that *Prophopithecus* is the ancestor of the modern anthropoids, thus *Dryopithecus* and *Propliopithecus* would belong to separate branches that had already separated from the hypothetical common primate stock According to R Broom, the common ancestors of man and the anthropoid apes are all undiscovered, and *Dryopithecus, Propliopithecus,* etc., are mere collateral branches, off the main line of descent.

The various hypotheses put forward are all highly speculative, resting on such questionable assumptions as that one can infer the whole anatomy of an animal from the pattern of the crowns of the teeth There is not even the beginning of a proof that man is descended from any of these lower primate forms.

In recent years Broom and a number of colleagues have urged the claims of certain fossils discovered in South Africa The first of these, found at Taungs in 1921, was that of a young anthropoid, of Pliocene or Lower Pleistocene date, which was given the name of *Australopithecus africanus* Since 1936 other specimens of the same type have been found, e g., *Plesianthropus transvaalensis, Paranthropus robustus* Broom holds that the *Australopithecus* type, though not directly ancestral to man, enables us better than any other fossil yet found to form an idea of what the anthropoid ancestor of man was like[6] Although Broom refers to the members of this *Australopithecus* group as "Ape-Men," most authorities hold that they are simply apes "There seems to be a general agreement among all students," says Franz Weidenreich, "that the *Australopithecinae* represent a true anthropoid group, i e., they are not hominids. . . The skulls of *Australopithecus africanus* and *Paranthropus robustus* are the skulls of apes and not of hominids"[7] The cranial capacity of these forms (about 500 c c. on the average) is sufficient to show that they are apes, not men, and E A Hooton argues that it is so small as to exclude them from the direct line of human ancestry He writes "Although these Pleistocene apes of South Africa are undoubtedly much closer to man than any existing or sub-human forms heretofore dis-

[6]Cf R Broom and G W H Schepers, The South African Fossil Ape-Men, Transvaal Museum, Pretoria, 1946

[7]Palaeontologica Sinica The Skull of Sinanthropus pekinensis, Chungking, 1943, p 268

covered, they lacked the brain overgrowth that is specifically human and perhaps should be the ultimate criterion of a direct ancestral relationship to man of a Pliocene ancestor"[8] Furthermore, these fossils are most probably of Pleistocene date, and even if they were Pliocene, they would be at once too recent and too different from man to be placed by the evolutionist in the direct line of human descent

The earliest human remains are found in Pleistocene strata, and so far as the existing evidence goes, it shows that man appeared suddenly as a complete type, quite distinct from any other primate, and did not evolve gradually from any other form On his first appearance in the strata, man is so different from the other primates, that the ordinary theories of Extreme Evolutionism have to postulate a long period of evolution extending back to the beginning of Pliocene and perhaps into Miocene times, i e, to the time when the line ancestral to man separated from the common primate or anthropoid stock These theories, however, are confronted with the serious difficulty that no trace of these ancestral forms has been found in Miocene or Pliocene strata

From the Middle Pleistocene onwards, we find human fossils, some of them differing a good deal from the modern type, but all of them certainly human "Mankind in its entity," writes Weidenreich, "represents one species in the morphological or physiological sense of the term Not only the living forms of mankind, but also the past forms—at least those whose remains have been recovered—must be included in the same species"[9] Opinions about the relative ages of these fossils seem to differ less than formerly, and it is now widely held that men of distinctly modern type lived at least as early as *Pithecanthropus* and before *Homo neanderthalensis,* two forms that used to be regarded as ancestral to modern man, connecting links between him and the anthropoids We shall deal briefly with some of the better-known of these fossils, in what seems to be their chronological order

The earliest human remains thus far discovered are those of *Eoanthropus dawsoni,* or Piltdown man They consist of several fragments of an obviously human brain-case, and the half

[8]Up from the Ape, Revised Edition, Macmillan, New York, 1946, p 288
[9]Apes, Giants and Man, Univ of Chicago Press, 1946, p 3

of a lower jaw with the condyle and a portion of the chin region missing The jaw, which has simian characteristics, was found at some distance from the skull fragments and palaeontologists still do not agree about whether it belonged to the owner of the brain-case. Hooton argues fairly convincingly that jaw and brain-case belonged to the same individual, and he points out that, despite its simian characteristics, the jaw-fragment can be incorporated in a jaw of approximately human proportions that would fit the skull The bones of the skull are thicker than in modern man, but otherwise the skull is of modern type in most respects, there was a dispute about the cranial capacity of the skull, but it is now generally agreed that it is about 1350 c.c., and therefore well within the human range

The fossil men of Galley Hill and Swanscombe are also structurally quite similar to modern man The Galley Hill skull was found in 1888 in Middle Pleistocene strata by persons fully aware of the importance of noting its position, but doubts were cast on its antiquity because it was difficult to reconcile the existence of so modern a type at so early a period with the evolutionary theory then dominant Sir Arthur Keith, for long a lone defender of the antiquity of the Galley Hill fossil, after recounting the story of its discovery, goes on to explain why its age was in question, in spite of its excellent credentials "Why is it, then," he asks, "that anatomists and geologists have been so reluctant to acknowledge the antiquity of the Galley Hill remains? The anatomist turns away from this discovery because it reveals no new type of man, overlooking the much greater revelation—the high antiquity of the modern type of man, the extraordinary and unexpected conservancy of the type The geologist regards the remains with suspicion for two reasons—first, he has grown up with a belief in the recent origin, not only of modern civilization, but of modern man himself. He expects a real anatomical change to mark the passage of a long period of time Further, at a much later date than the formation of the 100-foot terrace (where the remains were found), a very primitive type of man survived in Europe—such a type as answers exactly to the evolutionist's expectation of a human ancestral form The discovery of human remains of the Neanderthal type confirmed geologists in their opinion that Pleistocene man must be of a more primitive—at least of a

different—type from modern man Hence the rejection of all remains—such as those found at Galley Hill—which do not conform to this standard."[10]

In 1935, the soundness of Keith's opinion was vindicated by the discovery in Middle Pleistocene strata of the Swanscombe skull, which, according to Hooton, provides "a cast-iron, irrefragable case" for the existence of a modern type of man in Middle Pleistocene times The cranial capacity of the Swanscombe skull is about the same as that of the Galley Hill skull, and, to quote Hooton, "only the breadth of the occipital bone and the great thickness of both bones (occipital and parietal) are peculiar in comparison with modern remains of *Homo sapiens* "[11]

Other fossils, similar in type to those of Galley Hill and Swanscombe, and probably of equal antiquity, are those of Moulin Quignon, Clichy, Olmo, Bury St. Edmunds, Castenedolo and Abbeville

Pithecanthropus erectus is the name given by E Dubois to a skull-cap, femur, some teeth, and a fragment of jaw found at Trinil in Java in 1891-1892 The femur is straight, indicating that its owner walked erect, but the skull-cap is part of a skull that had simian characteristics, such as a receding forehead, prominent brow-ridges, and dimensions that are inferior to those of most modern men The femur was found 15 metres away from the skull, and many palaeontologists held that the two bones did not belong to the same individual, the femur being human and the skull-cap simian In 1936, however, G H R von Koenigswald found three more skulls of the *Pithecanthropus* type in the same area, and it now seems reasonably certain that *Pithecanthropus* is, in the words of Weidenreich, "a true man and a creature far above the stage of an ape "[12] Although the cranial capacity is only about 940 cc, there are types of modern man with skulls no larger

Sinanthropus pekinensis is the name given to a type represented by the remains of about forty individuals found at Chou-kou-tien, near Pekin Six skulls have the vaults more or less preserved, there are seven pieces of femora, two pieces

[10]The Antiquity of Man, Second Edition, Williams and Norgate, London, pp 265-266

[11]Up from the Ape, p 359

[12]Apes, Giants and Man, p 27

of humeri, a broken wrist and a broken clavicle. The brain-case, limb bones, and jaw are all distinctly human. According to Weidenreich, the average cranial capacity is about 1075 c c, with some individuals as high as 1300 c.c. With reference to a skull found in 1929, Weidenreich writes "The new find did not leave the slightest doubt that *Sinanthropus* was a true man, although a very primitive type—in any case, more primitive than any of the long-known Neanderthalians"[13]

Pithecanthropus and *Sinanthropus* resemble each other fairly closely. "That the types are closely akin," writes Hooton, "is incontestable"[14] They differ from modern man more widely than any other fossil form, but they are not ancestral to modern man, for when they lived men of the modern type were already in existence Hooton, in order to restore *Pithecanthropus* to his place in the ancestral line, urges that he is probably the descendant of a Pliocene type "It seems probable," he writes, "that the Javanese specimens of *Pithecanthropus* represent the late survivals into Pleistocene of an archaic type that must have come into being at least in Middle or Upper Pliocene."[15] This, however, is mere speculation, for no fossils of *Pithecanthropus* have been found in Pliocene strata The truth is that nothing is known of the ancestry of Pithecanthropus and Sinanthropus Weidenreich, the greatest living authority on these forms, writes "Where did these hominids come from? All the links are missing, so that we are entirely dependent upon conclusions drawn from living and fossil forms whose relation to the hominids is questioned"[16]

Palaeoanthropus heidelbergensis, or Heidelberg man, is the name given to a massive jaw, of great antiquity, found near Mauer in 1907 Some say this is the oldest human fossil, but according to C S Coon, it is not demonstrably older than the men of Piltdown, Galley Hill and Swanscombe.[17] The teeth are definitely human, and although the jaw is more massive than the ordinary modern jaw, instances have been found of modern men with a jaw almost as large It can be safely affirmed that Heidelberg man was truly human.

[13]Apes, Giants and Man, loc cit
[14]Up from the Ape, p 306
[15]Ibid, p 298
[16]The Skull of Sinanthropus Pekinensis, pp 260-261
[17]The Races of Europe, Macmillan, New York, 1939, p 23

Homo neanderthalensis, or Neanderthal man, is represented by a great number of fossils, of more recent date than those we have so far considered The first specimen was a skull found in the Neanderthal, near Dusseldorf, in 1856 Other fossils of the same type, some fairly complete, were afterwards found at Spy (Belgium), Krapina (Croatia), La Chapelle-aux-Saints, Le Moustier, La Quina (all in France), Gibraltar (found in 1848, recognized later), and elsewhere. Neanderthal man is definitely a man, not a pre-human or sub-human ancestor He used tools, buried his dead, and seems to have had an organized cult His cranial capacity, on the average, is not inferior to that of the modern European (1450 c c), and some individuals had very large brains, e g , the man of La Chapelle-aux-Saints, whose cranial capacity was 1620 c c The skull of Neanderthal man possesses certain simian features, e g , the supra-orbital ridges are very prominent and the forehead is low. He was not, as Boule and many other have said, stooped and incapable of walking upright, for the position of the ilium reveals that his station was absolutely vertical Nor was his head thrust forwards, for the position of the foramen magnum is situated in precisely the same place as in modern man, showing that the skull rested on the spinal column, not in front of it "It can be taken as definitely established," Weidenreich declares, "that the erect posture and all that is connected with its adoption were attained long before that phase (Neanderthal man) "[18]

Homo rhodesiensis and *Homo soloensis,* two other fossil forms, found in Rhodesia and Java respectively, resemble each other Both are certainly human, and, according to Coon, are not very different from the numerous and variable Neanderthaloid type [19]

Since 1931 a considerable number of Neanderthaloid skeletons have been found in Palestine, notably in the caves of Tabun and Mugharet-es-Skuhl, on Mt Carmel "Keith and McCown have demonstrated beyond serious doubt," Coon asserts, "that the Skuhl skeletons are intermediate between *Homo neanderthalensis* and *Homo sapiens,* and that Neanderthal man must therefore be included among the ancestors of modern races Thus the opinions of Hrdlicka, Aichel, and others, expressed

[18] Apes, Giants and Man, p 42
[19] The Races of Europe, p 23

earlier on a basis of equally valid but less striking evidence, are at last, in one sense or another, substantiated. We now know that the Neanderthal stock did not become extinct, but passed over into the genetic stock of modern man."[20]

More recent fossil forms, not notably different from modern man, are those of Cro-Magnon, Grimaldi, Combe-Capelle, Solutré, Chancelade (all in France), Afalou ben Rummel (Algeria), Brunn, Predmost (Czechoslovakia), Kanam, Kanjera (East Africa), and Wadjak (Java).

From this summary of the evidence at present available, it is clear that the human type has in the course of ages undergone a good deal of modification, and that races of men existed in the past who in their physical structure differed more widely from modern man than modern races differ from one another The fossil record is unfavourable to the theory that the human body has gradually evolved from some lower animal form, because the intermediate forms required to link man with this hypothetical ancestor are all missing If these "missing links" had ever existed, they would have been numerous and some of them would have been found by this, for, as we have said, the strata where they ought to be are rich in mammalian fossils What Reinke said almost fifty years ago is equally true today. "The only statement consistent with her dignity, that Science can make, is to say that she knows nothing about the origin of man."[21]

Philosophy goes further than Science and on the basis of scientific facts draws some philosophical conclusions It seems clear that the human body was not formed by gradual evolution but either arose from some lower form by a sudden immense mutation or was produced directly by the special intervention of God A mutation of such magnitude is quite outside the ordinary course of nature as we know it, and there are no natural causes known to us in terms of which it could be explained It is more probable, therefore, that the human body was directly formed by God The matter from which it was formed could have been living or non-living, and from the philosophical point of view, the alternatives seem equally probable

[20]The Races of Europe, p 28

[21]Der Turmer, V, Oct, 1902, Part I, p 13 Quoted in O'Toole, The Case against Evolution, p 346

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